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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A STUDY OF COGNITIVE PROCESSES: EFFECTS OF SCHOOLING AND LITERACY submitted by UDAYA NATH DASH in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in EDUCATIONAL PSYCHOLOGY.

ABSTRACT

Two separate studies were designed to investigate the cognitive consequences of schooling and literacy experiences within the cultural context of Orissa, a South Eastern province in India.

In Study One, the sample consisted of 250 subjects with 50 boys selected from each of the following subject populations: (a) 4-6 year old nonschooled children, (b) 6-8 year old nonschooled children, (c) 6-8 year old schooled children in Grade two, (d) 10-12 year old nonschooled children, and (e) 10-12 year old schooled children in Grade five. To keep the major sociodemographic characteristics of schooled and nonschooled children relatively homogeneous, the sample included only boys selected from middle-caste rural homes from 14 villages in the locality of Angul, Orissa.

All subjects were administered the marker tests of simultaneous, successive, and planning processes. Only 25 out of 50 children in each cell were given four Piagetian tests of concrete operational thinking. The remaining 25 subjects in each cell were given the Serial Short-Term Recall, and Clustering in Free Recall Tests to examine the influence of schooling on memory and retrieval strategies. Furthermore, 30 subjects in each group were administered the Syllogistic Reasoning Test. Only the schooled children took an adapted version of the Schonell Word Reading Test.

Results indicated that performance on Piagetian tasks increased as a function of age only, whereas the main effects of age, schooling, and their interaction were clearly observed for simultaneous, and successive coding processes. The intial year of schooling had a greater impact on successive than on simultaneous processing. The findings were interpreted in the context of the teaching-learning conditions in the school.

Although, neither age nor schooling was associated with the spontaneous utilization of the semantic information in the stimulus list, it was only the schooled children who tended to show increased clustering, when the stimulus list was partially structured by providing the category names as cues for retrieval. The structural aspects of memory as reflected by recency recall was found to be invariant with age or schooling experience, while the primacy recall improved as a function of age only. The results revealed a developmental trend but failed to register a significant influence of schooling on syllogistic reasoning performance. In the light of these findings, it is suggested that the information-processing modes, rather than concrete operational, memory, and problem solving skills appear to be more sensitive to the cognitive consequences of schooling. The results indicated that simultaneous rather than successive processing was involved in solving concrete operational, and verbal-logical tasks.

In Study Two, 20 literate and 20 illiterate adults were tested on simultaneous and successive as well as memory and problem solving tasks mentioned in Study One. Both the coding processes appeared to be influenced by literacy experience. The elementary forms of reading and writing did not seem to improve clustering, primacy and recency recall, or verbal-logical performance.

In conclusion, the findings from both the studies were essentially in agreement. The results failed to support the notion that elementary level of schooling or literacy experience produces mental capacities, which have widespread intellectual consequences. It is suggested that future research should concentrate on the levels of educational experience necessary for the development of various forms of cognitive skills, and delineate which processes are developing as a function schooling and are allowing schooled children to perform better on certain intellectual tasks, and not on others.

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I. INTRODUCTION

Despite great diversities in the nature of tasks used, the cultures studied and the children sampled, it has been demonstrated consistently that children who attend school perform at a significantly higher level on cognitive tasks compared to children who do not (Brown, 1977; Cole, Gay, Glick, & Sharp, 1971; Sharp, Cole, & Lave, 1979; Stevenson, Parker, Wilkinson, Bonnevaux, & Gonzalez, 1978). Schooling is associated with better performance on intellectual tasks, reduced within-group variability in performance, and greater differentiation of performance within the child (Stevenson et al., 1978).

The exact mechanisms by which schooling brings about such an effect are not clear. However, several speculations have been made regarding the beneficial effects of schooling. Bruner (1966) points explicitly to the use of written language in school which faclitates linguistic competence and thus symbolic functions in general. The structure of written language helps children to process information outside their own experience and develops their ability for generalization and abstraction (Greenfield, 1972). These speculations are further supported by Greenfield and Bruner's (1966) observation that the formal linguistic training imparted in schools improves children's ability to shift from one criterion of sorting to another, to state the basis of classification in full sentences, and to answer elaborately the question, "Why did you think the

items were alike?" Olson (1977a) remarks that exposure to the alphabetic script and printed text develops new modes of thought, which are linked with unique kinds of logical competency. Because of the formal linguistic training imparted in schools, children come to regard meaning as residing in the text, and can differentiate between 'what is said', and 'what is meant'. Instructions in the verbal mode and the written form of language produce decontextualized experience (Luria, 1976), where the principal emphasis rests on universalistic values, criteria, and standards of performance (Bernstein, 1966). Thus, the literate bias of schooling "transforms children's language from utterance to text" (Olson, 1977a, p. 278), and allows thought processes to be freed from concrete situations and actions, which in turn lead to symbolic manipulations of objects and events (Greenfield, 1972).

Another consequence of schooling, as noted by Scribner and Cole (1973), is evident in a child's ability to regard an event as an instance of a general class of events, and to search for general rules that can be applied to understand specific instances. A similar observation has been made by Vygotsky (1962), who suggests that children in school indulge in a process of inductive reasoning while mastering 'scientific' concepts. The method of instruction adopted in schools develops analytical thought useful for solving Piagetian concrete operational tasks (Bovet, 1974). As noted by Greenfield (1966), and Furby (1971), children in Western

type schools learn to reason logically on the basis of empirical experience, which diminishes their "magical thinking." Ashton (1975) similarly suggests that school children learn to appreciate processes rather than specific products, as they "speak ideas about ideas"(p. 495). They develop a conscious awareness of the mechanisms by which they solve cognitive problems, by being forced to code and recode information along increasingly abstract dimensions.

School's emphasis on verbal modes of instruction, context-independent thinking, and the search for universal principles may be related to some of the findings of Sharp, Cole, and Lave (1979). In summarizing their results on a large variety of cognitive tasks, Sharp et al. (1979) report strong education-related effects for tasks which are less structured and more hypothetical or which require taxonomic principles as the correct basis of classification. On the other hand, education-related effects are greatly reduced, and age-related effects become more prominent for tasks that are well structured or can be solved by taking recourse to real-world knowledge. Thus, it is apparent that schooling does not influence performance on all tests in an equal fashion; performance on certain tasks, especially those derived from laboratory studies of problem solving are more favorably influenced in comparison with other tasks. This is because schooling promotes certain specific cognitive skills such as deliberately remembering information as a goal in itself, dealing with abstract symbols, solving fancy mental

riddles, and the adoption of specific learning and memory strategies. Hence, a school child has an apparent advantage in a standard test situation by being able to apply these skills in a more efficient way. To what extent these test skills generalize to important nonschool settings is yet to be determined. This concern among investigators has recently given rise to the issue of the generalizability of cognitive skills learned in schools.

In a recent paper, Rogoff (1981) made three important observations regarding the generalizability of the findings of the previous studies. First, inferences about cognitive consequences of schooling have been made without due regard to the appropriateness of the psychological tasks and their differential validity for schooled and nonschooled populations; factors such as familiarity with the test material, language of testing and the test situation itself have not been given sufficient consideration. Second, performance differences between schooled and nonschooled children have been largely attributed to the effects of schooling when in fact the two samples differed in a number of other characteristics. Hence, it appears that the influence of schooling might have been overestimated in the presence of factors that are extrinsic to, but covary with schooling. Finally, in order to understand why and how schooled children differ from their nonschooled counterparts, it is not sufficient to just describe the results obtained on standard psychological measures; rather

one must comprehend the psychological mechanisms by which these differences come about. One proposal to meet this requirement is to explain these differences by taking recourse to information processing models of cognition; that is to examine which processes are developing as a function of schooling, and thus allowing children to perform at a relatively competent level on psychological tasks.

The present research attempted to address these issues. In the next several paragraphs, the findings from studies on schooling and cognition are briefly described to provide a context for developing a rationale for the present study.

Three broad categories of cognitive tasks have been used in studying the effects of schooling. These are standardized intelligence tests (Schmidt, 1960), Piagetian tasks (Dasen, 1977; Fahrmeier, 1978; Goodnow & Bethon, 1966; Greenfield, 1966; Nyiti, 1976; Philp & Kelly, 1974), and tasks derived from laboratory studies of memory, problem solving and concept attainment (Sharp et al., 1979; Stevenson et al., 1978; Wagner, 1978, 1981). Compared to Piagetian tasks, the standardized or laboratory-based tasks, in terms of their content and context in which they activate cognitive operations, are relatively biased in favor of the schooled population. Although, it is not utterly surprising to find school-nonschool differences on these tasks, their use has clearly demonstrated how schooling influences certain specific cognitive skills (Sharp et al., 1979; Stevenson et al., 1978; Wagner, 1981). These sets of tasks

can be subsumed under the information-processing framework. The present study used Piagetian and some laboratory-based tasks, as well as those used in the context of an information-integration model (Ashman, 1978; Das, Kirby, & Jarman, 1975, 1979). Tasks related to this model measure simultaneous, successive, and planning processes, and can be viewed as belonging to the family of theories that constitute the larger information processing framework. The model as well as the tasks are described in later sections. With the help of these tasks, the study attempted to investigate the cognitive consequences of schooling.

Piagetian tasks have been attractive to cross-cultural researchers because, compared to intelligence or laboratory-based tests, they are easily suited and adapted to cultural variations (Bovet, 1974). They also reflect a more general thinking pattern according to Piagetian theory, which provides a dominant perspective in the field of developmental research. These tasks are less biased in favor of the schooled population. However, the findings from studies using Piagetian tasks have not always been consistent. While several studies report no direct relationship between formal schooling and cognition (de Lemos, 1969; Fahrmeier, 1978; Goodnow & Bethon, 1966; Kamara & Easley, 1977; Kiminyo, 1977; Mermelstein & Shulman, 1967; Nyiti, 1976), others have found that schooled children acquire concrete operational concepts much faster and earlier compared to nonschooled children (Greenfield, 1966;

Kelly, 1977; Laurendeau-Bendavid, 1977; Okonji, 1971; Owoc, 1973; Philp & Kelly, 1974; Stevenson et al., 1978).

Conflicting findings like these may be partly attributed to selection bias. For example, in some studies (Fahrmeier, 1975; Stevenson et al., 1978) schooled children differed from their nonschooled counterparts only after a few weeks or months of schooling, while in other studies, differences did not emerge until about Grade 3 or 4 (Owoc, 1973). Longitudinal studies comparing the performance characteristics of schooled and nonschooled groups indicate that differences between the two groups existed prior to school entry (Irwin, Engle, Yarbrough, Klein, & Townsend, 1978). Other cross-sectional studies have reported schooling as a significant variable enhancing performance on cognitive tests; however, the demographic characteristics that covary with schooling were left uncontrolled. Consequently, the influence of schooling on cognitive test performance might have been overestimated. Such biases in sample selection, and not schooling itself may have unduly attributed cognitive superiority to those who attend schools. Many studies, however, failed to mention this as a problem while describing their sample characteristics.

Apart from the problem of selection bias, several other methodological difficulties are also related to the issue of the appropriateness and the validity of psychological tasks for schooled and nonschooled populations. Kamara and Easley (1977) and Nyiti (1976) point out three such areas of

difficulty: (a) linguistic and cultural differences between the investigator and the subject, (b) tendency to treat Piagetian tests as standardized performance tests, and (c) inaccuracy in determining subject's age in non-Western societies. When these difficulties were corrected in Nyiti's (1976) work among the Meru of Tanzania and in Kiminyo's (1977) work among the Kamba children in Kenya, the differences between schooled and nonschooled groups disappeared. Several other studies carried out in different parts of the world have also supported these findings (de Lemos, 1969; Fahrmeier, 1978; Goodnow & Bethon, 1966; Mermelstein & Shulman, 1967; Peluffo, 1967; Price-Williams, 1962; Youniss & Dean, 1974). Dasen (1972) also cites studies by Wadell, Kelly, and Heron as reporting no direct relationship between schooling and concrete operations.

The studies which address the methodological concerns noted above were conducted in African villages. It was decided to carry out the present research in villages located in a South-Eastern state of India, because the experimenter and the subjects were native speakers of Oriya, the language of the state. Relatively speaking, there were no linguistic or cultural barriers between the subjects and the experimenter. The Piagetian tests were administered in a clinical interview-type of format. The schooled and nonschooled samples came from a relatively homogeneous socio-cultural background. Since some of the methodological requirements of earlier studies were satisfied, it was

expected that the present findings would be similar to those obtained in the African studies (Kamara & Easley, 1977; Kiminyo, 1977; Nyiti, 1976). In other words, while performance on Piagetian tasks would improve as a function of age for both groups, there would be no differences in developmental changes between schooled and nonschooled groups.

One of the important areas of cross-cultural research is the study of the influence of schooling on memory and problem solving skills (Cole et al., 1971; Rogoff, 1981; Sharp et al., 1979; Stevenson et al., 1978). The tasks used to assess memory and retrieval strategies permit, but do not require, the subject to supplement the raw information by engaging in some active cognitive strategies. School children recall more words in a memory task, and tend to show increased clustering in their recall, since they are able to utilize taxonomic principles as the correct basis of classification. Following the distinction between structural and control processes in memory (Atkinson & Shiffrin, 1968), Wagner (1978) found that the structural features (recency recall) of memory remained unaffected by age and schooling experience, while control processes, especially rehearsal strategies, developed as a function of age only in schooled children, and affected 'primacy recall'.

Problem solving tasks, unlike memory tests, focus on the way children transform raw information to produce a correct answer. The syllogistic reasoning task has been

frequently used to examine how children engage in 'theoretical thinking' (Bickersteth, 1979; Fobih, 1979; Luria, 1976; Sharp et al., 1979). A relatively low level of education influences performance on verbal-logical problems. The present study attempted to investigate the cognitive consequences of schooling with reference to some memory and problem solving skills. It was expected that school-nonschool difference on this set of tasks would be wider compared to that obtained with Piagetian tasks.

Examining schooled and nonschooled groups on concrete operational, memory, and problem solving skills was only one aspect of the study. As mentioned earlier, the other was to examine how efficiently schooled children integrate information compared to their nonschooled counterparts. The study aligned itself with a process-oriented approach, and attempted to study the cognitive effects of schooling within the theoretical framework of the information-integration model proposed by Das, Kirby, and Jarman (1975, 1979), and Ashman (1978). The model constitutes an integration of the British factor-analytic tradition and Soviet clinical research (Luria, 1966). This model identifies two coding processes known as simultaneous and successive syntheses. The two coding processes are viewed as two habitual modes of processing information employed by an individual while solving cognitive problems. Both are centrally mediated processes.

Simultaneous processing refers to the organization of discrete information into simultaneous arrays, which are quasi-spatial in nature and are surveyable. It is evidenced, for example, in reading comprehension, logical and mathematical operations, and in copying figures and patterns. Successive processing, on the other hand, is a temporal, and sequence-dependent form of information-integration, having little to do with relational thinking. The important operational distinction between the two coding processes lies in whether or not the system is totally surveyable at any given point in time. The two processes are nonhierarchical in nature; their use is determined by the demands of the task and the individual's habitual preference for one or the other mode of coding information.

Unlike memory and reasoning abilities, where memory is treated as a lower level skill than reasoning (Jensen, 1970), the simultaneous-successive model does not imply any hierarchy between the two coding processes. Although, simultaneous synthesis is quasi-spatial in nature, and successive synthesis is related to a temporal-auditory factor, it is quite reasonable to assume that auditory events may require simultaneous processing while visual events may need successive processing. Both these syntheses lend their importance to another component in the central processing unit called 'planning', which in turn determines the nature of syntheses for solving cognitive tasks.

This model based on simultaneous, successive, and planning processes provides an alternative way of categorizing mental ability. Several studies provide empirical evidence to support the independence of the two coding processes (Das, Cummins, Kirby, & Jarman, 1979; Das, Kirby, & Jarman, 1975, 1979; Jarman & Das, 1977; Kirby & Das, 1977, 1978). Recently, simultaneous and successive syntheses have been related to reading and writing experiences, and verbal comprehension (Cummins & Das, 1977), which are presumably fostered in children in the first few years of schooling. While successive processing is highly related to initial reading performance, gradually simultaneous processing becomes more and more important for reading and comprehension at an advanced level. On the basis of these findings, it was expected that for both coding processes, significant effects of schooling, age, and their interaction would be obtained. As previously mentioned, significant effects of schooling and its interaction with age were not expected for Piagetian tasks.

Apart from schooling, this study was also concerned with examining the cognitive consequences of literacy. The exposure to the alphabetic script and school-based written texts provides one of the important reasons explaining why schooled children perform better on cognitive tasks. If written language is associated with unique kinds of logical competency and memory and problem solving skills, should the literates who are exposed to the beneficial effects of

written texts show higher order and generalized mental capacities? In this context, Scribner and Cole (1978a,b) note that there are two dominant perspectives in accounting for the cognitive consequences of literacy: one is characterized as a 'developmental perspective' and the other as 'practice perspective'. Working within a developmental perspective several authors (Greenfield, 1972; Olson, 1977a,b) suggest that exposure to alphabetic script allows new modes of thought, higher form of abstraction, and context-independent thinking which have widespread cognitive consequences. In their discussions, the cognitive consequences of schooling and literacy are not usually treated separately.

On the other hand, the work of Scribner and Cole (1978a,b, 1981) with the Vai literates in Liberia provides evidence to suggest that literacy, as such, does not produce generalized intellectual capacities. They found little difference between nonschooled Vai literates and nonliterates on logical reasoning, and classification ability which were expected to be especially sensitive to experience with written language. The nonschooled Vai literacy was associated with the ability to analyze oral speech, to give clear instructions, and to specify the nature of grammatical errors in spoken Vai. This perspective of viewing nonschooled literacy as producing certain specific cognitive skills has been labeled as the 'practice' perspective. Scribner and Cole (1978a) suggest the need to

examine the effects of literacy apart from the effects of schooling and also to make functional analysis of the skills involved in these abilities.

In interpreting the discrepant effects of schooling and literacy, Scribner and Cole (1978a) remark that other than reading and writing experiences associated with the written form of language, school-based learning provides the opportunity "to treat individual learning problems as instances of a general classes of problems" (p. 452), and to search for more general rules to organize knowledge. According to the 'practice' perspective, the generalized intellectual consequences which are assumed to be the results of schooling may not be witnessed in the comparison of literates and nonliterates. In their functional analyses of the Vai script, Scribner and Cole have also suggested that the skills fostered by Vai literacy may not be witnessed in other cultures and with different scripts. Whether or not their findings are specific only to Vai literacy is yet to be determined. The present research, therefore, is aimed at studying the cognitive consequences of adult literacy programs in India.

In summary, two separate studies were designed to examine the cognitive effects of schooling and literacy separately, within the theoretical framework of the information-integration model proposed by Das et al. (1975, 1979) and Ashman (1978). In addition, the first study examined the influence of schooling and age on concrete

operational thinking within the context of Piagetian theory, which provides a significant framework in the field of developmental research. Following the trend from previous research, the separate influence of schooling and literacy on some memory and problem solving skills was also investigated. With the help of concrete operational, memory, and problem-solving tasks as well as those used in the context of the information-integration model of Das et al. (1979), the two studies attempted to examine the following questions:

1. Does the course of cognitive development proceed similarly in schooled and nonschooled children?
2. Does schooling influence performance on all tasks in an equal fashion, or is it that the performance superiority of schooled children would be evident on some tasks, and not on others?
3. How efficiently do schooled children integrate information compared to their nonschooled counterparts? How are the two coding processes (simultaneous and successive) related to performance characteristics on concrete operational, memory, and problem solving tasks?
4. Does elementary literacy training produce the same kinds of cognitive effects as does schooling?

II. REVIEW OF LITERATURE

This section presents a selective review of the research, inferences, and implications related to the cognitive consequences of schooling and literacy. In discussing the relationship between schooling and cognition, evidence from both Piagetian and experimental research are cited. These citations predominantly emphasize cross-cultural studies and their implications. Since the information integration model of Das and his colleagues (Das et al., 1979) has been used to examine the influence of schooled and nonschooled literacy, the section begins with an explication of the model, and its background and empirical research.

A. Simultaneous-Successive Synthesis and Planning

Recent research on information processing (Ashman, 1978; Das, Kirby, & Jarman, 1975, 1979) has developed an alternative model of mental abilities, which integrates Russian clinical research (Luria, 1966), and North-American and British factor analytic studies (Jensen, 1970; Vernon, 1960). The model proposes four units of information integration: the input, the sensory register, the central processing unit, and the output unit. Input can be made either in a simultaneous or successive manner. Then the stimulus is registered by the sensory register and passed on to a central processing unit. The model comprises three aspects of this central processing unit: simultaneous

synthesis, successive synthesis, and planning. The manner in which information is processed in the central processing unit is independent of the nature of the input.

Background of the Model

The roots of this model lie in Luria's examinations of patients with lesions in the left hemisphere of the cortex (Luria, 1966). According to Luria, the cortex is engaged in two types of integrative activity: simultaneous and successive. Lesions in the occipital-parietal region result in the impairment of simultaneous processing, while lesions in the fronto-temporal area lead to disturbances in successive processing. Lesions in the frontal lobe are associated with disturbance in planning and programming behavior. These three forms of information processing have developed from an examination of the common characteristics of various tasks associated with particular areas of the brain.

Luria's clinical work suggests that the brain has three functional units. The first unit which controls arousal and attention is located in the upper and lower parts of the brain stem, particularly in the reticular formation. The second unit plays a decisive role in the analysis, coding, and storage of information. In contrast to the functions of the first unit, which are mainly of a general nature, the second functional unit carries specific assignments: coding information simultaneously or successively. The occipital and parietal regions are responsible for the simultaneous

synthesis of a collection of information inputs. The fronto-temporal region is responsible for successive synthesis i.e., sequential processing of information. The third unit comprising the frontal lobe plays a decisive role in the formation of intentions and the programming of behavior. Neuropsychological evidence provides support for the independence of these coding and planning systems in cognitive functioning.

Simultaneous synthesis is quasi-spatial in nature and refers to the organization of information into a meaningful composite or pattern. Successive synthesis, on the other hand, refers to the processing of information in a serial order. The important distinction between the two coding processes lies in whether or not the system is totally surveyable at any given point in time. According to Luria, both these coding processes are of three varieties: direct perception, mnestic processes, and complex intellectual processes. It is the third variety of synthesis that Das and his colleagues have examined in building up the information-integration model.

Recently Ashman (1978) has extended this model to include a planning component. The planning activity involves: (a) intention to plan, (b) actual formation of plans, (c) effective utilization of plans for regulating behavior, (d) checking the desired effectiveness of a plan, and (e) shifting of strategies to suit the demands of the situation.

Both coding processes lend their importance to planning, which in turn also determines the nature of syntheses. Performance on any cognitive task requires a certain amount of planning and strategic behavior. This is also true for performance on coding tasks used in the studies of Das and his colleagues. However, the tasks such as the Visual Search and the Trail Making used to study planning (Ashman, 1978) explain some additional variance over and above the minimum amount of strategy which might be involved in coding tasks. This is why the emergence of a 'planning' factor was possible in Ashman's work. Similarly, a minimum amount of coding information is necessary for planning to occur. Hence, with younger subjects or subjects suspected to have some deficits in coding, the 'planning' and 'coding' would not emerge as independent factors. In a pilot study by the author, it was found that deaf children were poorer in successive processing. In this particular study, the emergence of a 'planning' factor was not possible; the planning tasks such as the Trail Making and the Visual Search behaved as coding tasks.

Empirical Evidence

Several studies by Das and his colleagues provide empirical evidence to support the independence of simultaneous, successive, and planning processes in human behavior. The battery of tests employed to tap these modes of processing includes several measures of simultaneous processing (Ravens Progressive Matrices, Figure Copying, and

Memory for Designs), successive processing (Serial Recall, Visual Short-Term Memory, and Digit Span), planning (Visual Search and Trail Making), and speed of processing (Word Reading and Color Naming). The early work concentrated on finding the emergence of simultaneous and successive factors across IQ groups (Jarman, 1975), age-groups (Molloy, 1973), socio-economic status (Das & Molloy, 1975), cultures (Das, 1973; Das & Singha, 1975), and in Canadian native children (Krywaniuk & Das, 1976).

Recently simultaneous-successive synthesis has been related to language (Das, Cummins, Kirby & Jarman, 1979), reading, writing, and verbal comprehension (Cummins & Das, 1977), and with traditional models of abilities (Jarman, 1978; Kirby & Das, 1978). In all these studies, factors identifiable as simultaneous and successive processes were obtained. The model has also been used as a basis for remediation of learning difficulties (Krywaniuk & Das, 1976). Ashman's recent work (Ashman, 1978) has incorporated a planning dimension into the Das et al. (1975) model by examining the coding and planning processes of retarded and nonretarded adults.

The following are some of the specific considerations which guided the adoption of the model in the present study: (a) processes have a greater proximity to behavior and performance compared to abilities (Messick, 1973); (b) the use of any mode of processing depends on the demands of the tasks and the individual's habitual mode of processing

information as determined by socio-cultural and genetic factors; unlike abilities, processes are changeable; (c) the same task involves the use of different kinds of processes in different groups; (d) unlike factor analytic studies of memory and reasoning (Burt, 1972; Jensen, 1970), where memory is treated as a lower level skill, the simultaneous-successive model does not invoke a hierarchy of mental abilities (Jarman, 1978); (e) through intervention programs, the loadings on some tests were found to change in a manner that is supportive of the model i.e., children after tutoring learned to use more appropriate processes than they were using previously; and finally (f) the simultaneous-successive model has advantages over a simplistic verbal-nonverbal dichotomy, because it is proposed that verbal as well as nonverbal stimuli can be processed in either a simultaneous or successive manner.

Cross-cultural Studies

The cross-cultural studies (Das, 1973; Das & Pivato, 1976; Das & Singha, 1975) based on the simultaneous-successive model suggest that a particular mode of information integration such as successive processing may be used by certain non-white groups in tasks which usually call for simultaneous processing from white children. There appears to be a preference for a particular mode of processing information in a given culture. The preference for any mode of processing is largely influenced by the experiences through which subgroups pass, and these

experiences are reflected in the nature and style of their thinking.

In a study, comparing the performance of white Canadian children and high-caste children from Orissa, India, it was found that the children from India were using successive processing in the Ravens Progressive Matrices, which invariably elicits simultaneous processing in white children. Canadian native children have also been shown to adopt successive processing in solving the Ravens Progressive Matrices. When appropriate remedial programs were used, these children approached the same task with a simultaneous strategy (Krywaniuk & Das, 1976). Before intervention, the Progressive Matrices had the highest loading on successive factor, but after intervention there was a major shift to the simultaneous factor. The loadings changed in a manner supportive of the model.

In another study, comparing Brahmin (high-caste) and Harijan (low-caste) children, Das & Singha (1975) found that birth in a high-caste family was associated with superior performance in speed and successive tasks. Das & Pivato (1976) also found that Brahmins were superior to Harijans in all three successive tasks (Serial Recall, Visual STM, Digit Span). The Brahmin home is characterized by a rich scholastic tradition where oral as well as written language is necessary for certain religious practices. Hence it facilitates successive-verbal processing. In all these cross-cultutal studies, factors known as simultaneous and

successive syntheses were obtained.

The above studies used school children only. The information with regard to how schooling contributes to the development of coding and planning processes is lacking in these studies. Hence the inferences regarding the influence of caste and urban-rural environment are confounded with the effects of schooling. The present study proposed to investigate the effects of schooling on the development of simultaneous, successive, and planning processes.

B. Cognition and Schooling: Evidence from Piagetian Research

In most of the discussions of schooling and cognitive competence, the results are mainly based on three types of tasks: standardized intelligence tests (Schmidt, 1960), Piagetian tasks (Goodnow & Bethon, 1966; Greenfield, 1966; Kiminyo, 1977; Mermelstein & Shulman, 1967; Nyiti, 1976; Stevenson et al., 1978), and tasks derived from laboratory studies of problem solving and concept attainment (Stevenson et al., 1978; Wagner, 1978). Piagetian tasks have been widely used, as they assess a relatively more general pattern of thinking, and are easily suited and adapted to cross-cultural variations (Bovet, 1974).

In any work which is developmental in nature, Piaget's work and methods must be given due consideration (Larsen, 1977), as his theory provides the most dominant framework in the field of developmental research. As such, Piagetian tasks were used in the present study to examine the effects

of schooling. Schooling provides a kind of experience which, it can be argued, may affect the cognitive structure in a manner explainable within the Piagetian framework. A brief overview of Piaget's theoretical model and the Piagetian tasks used in the present study seems to be in order.

Theoretical Model

Piaget's stage theory of intelligence assumes an invariant hierarchy through which individual development must progress. The model postulates that cognitive development is a stage-like process, in which each successive stage is governed by its own unique set of logical structures (Brainerd, 1978). The cognitive structures expand in the direction from simple to complex forms, and the intellectual acts result from the interaction of cognitive structures with cognitive functions and the environment.

Each of the successive stages of cognitive development satisfies a certain set of cognitive criteria: (a) qualitative change in cognitive contents, (b) a culturally universal invariant sequence in the overall progression of stages, (c) inclusion of cognitive structures of each preceeding stage with each successive stage, and (d) an overall integration of the structures at each stage.

In order of their emergence, the four chronologically successive stages are: the sensorimotor stage, the pre-operational stage, the concrete-operational stage, and the formal operational stage. The rate of development in the

concrete operational period has been widely researched in cross-cultural studies of schooling and cognition, as it spans the age-range (7 to 11 years) of initial school attendance.

The major feature of the concrete operational period is that children's thought processes lose their intuitive character, and become more rigorous and logical. Children in this stage can now reason; however, their logical reasoning is only applicable to concrete operational inputs. This period has a special importance in that the child becomes increasingly interactive with his environment and comes to realize that the transformation of a substance does not change the amount of substance, unless some of its parts are removed. The child gradually learns to deal effectively with his environment within systems of logical classification, seriation, numbers, spatial-temporal coordinates, and causality. The cognitive characteristics at this stage include acts of compensation, identity, and reversibility. This period of development provides a unique opportunity to follow the genesis of the child's thought processes and to determine the influence of education on the development of these processes. The present review focuses on three task-related aspects of concrete operational thinking: conservation, transitive inference, and class inclusion.

Conservation: The concept of conservation refers to the appreciation of the invariance of an object's identity under diverse changes in its appearance. Piagetian psychologists

consider conservation as reflective of the basic structure of child's thought processes during the concrete oerational stage. Unlike standardized tests, conservation experiments study the development of basic processes of reasoning through a clinical method which can be adapted to varying cultural situations. The inference about the presence or absence of a requisite cognitive structure is reached through a 'judgment' or 'explanation-of-judgment' criterion or sometimes through both. The explanation-of-judgment criterion requires the child to state the reasons for his answer.

Piaget (1952) claims that conservation emerges around 7-9 years of age. In Piaget's account, the age of onset of conservation is influenced by the content of the task, and the method of representation required (Piaget, 1970). Although, various forms of conservation are the markers of concrete operational stage, they are not achieved at exactly the same chronological age. Several researchers, however, have supported Piaget's claim that none of the conservation concepts emerges before seven years of age (de Lemos, 1969; Kiminyo, 1977; Okonji, 1971; Opper, 1977).

The thought processes underlying the attainment of conservation are decentering, reversibility, and compensation. These processes are not independent of one another; rather they operate in an integrated fashion in solving conservation problems. Decentering refers to the fact that the child does not pay attention to a single

striking dimension of the objects. According to Piaget, a cognitive organization is reversible if it is capable of following a series of transformation states of the objects, while retaining the potentiality to follow the series back to its original state of display. Closely linked to reversibility is the concept of compensation, which enables the child to recognize that the transformation changes the objects in two dimensions simultaneously. In order to be able to solve conservation problems, the child must coordinate the dimensions into a system such that variations in one dimension are compensated for by variations in another dimension. However, a recent review by Silverman and Rose (1982) suggests that the ability to conserve may be attained without ability to compensate.

Piaget (1967) proposes that the child passes through three stages of equilibration in achieving conservation. First, the child continually responds to a single striking dimension, and ignores paying attention to other relevant dimensions. Secondly, the judgments fluctuate between both the dimensions either on the same problem or on a variety of problems. Finally, all the dimensions are attended to and related simultaneously and the child attains conservation. The ability to conserve develops only when thought is reversible. The conservation concept is important in that the child can acquire conservation spontaneously and independently at the age of seven without any specific instructions or teaching aids. This is one of the many

reasons explaining why many investigators are interested in determining the influence of education on the acquisition of conservation.

Transitivity: The ability to make transitive inferences distinguishes a concrete operational from a preoperational child (Piaget & Inhelder, 1974). The transitive inference task requires the child to infer the relationship between two objects, given the relationship of each separately with a third one. For example, given the premises, "Tom is taller than James," and "James is taller than David," a concrete operational child can deduce that Tom is taller than David, whereas a preoperational child cannot. According to Piaget, transitive reasoning evolves as a product of several qualitatively distinct developmental stages, each characterized by its own logical structures.

In attaining transitivity, the child progresses from a categorical to a relativistic conception of relations. The two basic thought processes required for transitive inference are decentering and reversibility (Flavell, 1963). In Piaget's account, the age of onset of transitivity is influenced by the content of the task, and the method of representation required. Thus, transitivity of length is attained at 7 or 8 years of age (Piaget, 1970), while weight transitivity emerges two years later (Piaget & Inhelder, 1974). In terms of the method of representation, children solve transitivity problems with perceptible objects earlier than those where the form of representation is verbal (Glick

& Wapner, 1968; Piaget, 1968). Piaget (Piaget & Inhelder, 1974) attributes the variations in the age of attainment of transitivity to the resistance of various contents and methods to the prerequisites of the logical structure of transitivity.

Piaget's explanation of transitive inference as well as the age of its onset has been supported by a number of other researchers (Murray & Youniss, 1968; Smedslund, 1963; Youniss, 1975; Youniss & Furth, 1973). However such support has not been unequivocal (see review by Breslow, 1981; Thayer & Collyer, 1978). Intial criticisms in regard to transitivity (e.g., Braine, 1959) were directed at the age of its onset, while the more recent ones challenged Piaget's explanation of how children solve transitivity tasks (Bryant, 1973; Bryant & Trabasso, 1971; Trabasso, 1977; Trabasso, Riley, & Wilson, 1975). Trabasso and others argue that a child's solution of the transitivity problem involves a simple linear ordering of the objects to be compared; thus, it may not necessarily involve the kind of inferential reasoning that Piaget emphasizes. However, as Breslow (1981) points out, demonstration of a mental seriation of objects by the children who can solve the transitivity tasks does not violate the basic tenets of Piagetian arguments; performance on transitivity tasks can still be accounted for by the logical structure necessary for concrete operational thinking.

Class inclusion: Class inclusion refers to the child's

appreciation that a class (e.g., animals) contains more elements than any of its constituent subclasses (e.g., cows), and therefore, a class is bigger than or at least as big as one of its subclasses. Although there have been complex information-processing analyses (Klahr & Wallace, 1976; Wilkinson, 1976) outlining steps in children's class inclusion reasoning, in Piaget's writing, class inclusion depends on the child's ability to perform two operations: one involving addition of classes (e.g., tulips + roses = flowers), and the other involving reversibility, which may be termed substraction of classes (e.g., with tulips and roses given, roses = flowers - tulips). There are three distinct stages through which the child passes in acquiring the class inclusion concept. In the first stage, the child does not understand that the class of 'brown beads' is contained in a superordinate class of 'wooden beads'. So he responds by translating the superordinate-subset comparison into a comparison between subsets. The second stage is marked by the child's developing awareness that 'brown beads' constitute a subordinate class of 'wooden beads', but his judgment fluctuates from one situation to another. In the third stage, irrespective of situations, materials, and procedural variations in the task, the child understands that 'brown beads' are included in the class of 'wooden beads', and therefore, the former contains a fewer number of elements than does the latter.

According to Piaget (1952), class inclusion develops by approximately 7 or 8 years of age. However, this claim has not always been supported. Winer (1980) reported that studies showing the late development of this concrete operational skill outnumber those showing early development by a ratio of 3:1. The inconsistencies in the results may be attributed to many procedural and population variables. Several studies suggested that class inclusion items, presented purely in verbal form, were less difficult than when the items were presented in pictorial form (Winer & Kronberg, 1974; Wohlwill, 1968). This outcome is labeled as the 'verbal facilitation effect', which presumably operates due to the absence of distracting perceptual cues.

Studies on school children (Sharp, Lave, & Cole, 1979; Stevenson et al., 1978) reveal that they learn to search for general rules which provides them with a basis of classification of events, and to learn the relationship between a subclass and a class. They learn to categorize objects which belong together on the ground that they share some properties in common. With this background in learning experience of schooled children, the influence of schooling on the development of class inclusion concept needs to be studied.

Relationship with the Simultaneous-Successive Model

Processes underlying Piagetian concrete operational skills have been recommended for study by several authors (Thayer & Collyer, 1978; Winer, 1980). Winer (1980) suggests

that correlational studies should be designed in a manner that performance on Piagetian tasks may be related to changes measured on different types of cognitive tasks. Valuable information can be obtained if these other cognitive tasks are hypothetically linked to the measurement of processes, which are undergoing change while concrete operational thought is developing.

Consistent with this line of thought, Mwamwenda (1981) investigated the relationship of simultaneous and successive coding processes with concrete operational thought. He found that simultaneous processing was largely involved in solving Piagetian tasks. A similar finding was also obtained by Cummins and Das (1978) with regard to class inclusion performance. The empirical investigations relating concrete operational thinking are only limited to these two studies. However, an examination of the underlying logical structures that characterize various forms of concret operational thought suggests that the characteristics of these structures are compatible with simultaneous, and not with successive processing.

Basic to all concrete operational skills is the child's ability to coordinate information from various perceptual states in order to arrive at a correct judgment. Reversibility, compensation, and hierarchical classification are all logical-spatial concepts like simultaneous synthesis. According to Piaget, a preoperational child is only capable of linking perceptual states or actions in a

sequential order, while a concrete operational child can display an all encompassing purview of all the perceptual states. The latter is able to hold in memory the past and the present states, while being able to anticipate the future. Thus, a simultaneous mode of integration provides an appropriate strategy in solving concrete operational tasks.

In conservation, simultaneous processing might be helpful for coordinating information from two dimensions to appreciate that variation in one dimension is simultaneously ordered with variation in another dimension. Similarly, in attaining transitivity, the child perceives the relativistic conceptions of relations, and understands that an object can have more than one relationship with other objects simultaneously. In achieving the concept of class inclusion, the child must be able to grasp the relationship between the superordinate and the subordinate classes; that is, he must be able to compare a whole and a part of the whole. From an examination of these processes, it seems reasonable to assume that simultaneous processing is linked with concrete operational skills. On the basis of a factor analytic approach, Carlson and Weidl (1977) observed that concrete operational tasks require the use of simultaneous processing. In view of this, it would be of interest to examine the pattern of relationship of simultaneous and successive processing and concrete operational skills for both schooled and nonschooled samples in the present study.

Schooling and Piagetian Research

Piaget has emphasized the role of cross-cultural studies in extending and clarifying the basic tenets of his theory. According to Piaget, four sets of factors are responsible for cognitive development: (a) the biological factors which interact with the environment during maturation and growth, (b) 'equilibration' factors which arise as the young organism interacts with his environment, (c) social factors of inter-personal coordination which arise as the child learns to coordinate his behaviors with others through exchange of information with adults, and (d) educational and cultural transmission factors through which the child is pressured to learn about distinct features of his environment.

The question of the effects of schooling on concrete operational skills has become a matter of considerable concern in cross-cultural research. There are basically two lines of reasoning associated with why schooling should or should not influence performance on Piagetian tasks. The first approach considers the teaching-learning conditions in schools as beneficial for the development of reversibility, decentering, compensation, and logical concepts of addition and substraction, which are crucial for solving concrete operational tasks. The second approach focuses on the organism-environment interaction in out-of-the-school settings, which are essential for the development of concrete operations; accordingly it is hypothesized that

there would be no influence of schooling on Piagetian skills. These two approaches can best be conceptualized within the context of a model proposed by Furby (1971), which is comprised of two enviromental dimensions: (a) the degree of magical thinking versus empirical reasoning, and (b) the degree of perceptual flexibility as a result of interaction with objects (manual versus automated environment). This model has been employed to interpret the discrepant results obtained from Piagetian studies of schooling and cognition.

In her study on Wolof children in Senegal, Greenfield (1966) found that schooling was the most significant variable influencing operational thought. The schooled Wolof children differed from nonschooled Wolofs with whom they shared their living and socio-cultural environment. The rural schooled Wolofs exhibited patterns of development similar to the ones obtained from urban schooled and American schooled children. Greenfield remarked that "the first effect of schooling is to increase their analytic attention to perceptible features of situations such as our experiment, and that this effect is then followed by a systematic and drastic reduction in the importance of such features" (p. 237). Schooling does increase analytic perception; whether or not the attention to perceptible features is reduced after two years of schooling, as in Greenfield's study, is doubtful. Bovet (1974) believes that it is not the gradual reduction over school years in

attending to the perceptual features; rather it is the mastery in coordinating the perceptual features by compensation, which gradually leads to the attainment of the conservation concept. Many studies conducted in various parts of the world have obtained similar results in that schooled children perform at a significantly higher level than nonschooled children on Piaget's tasks of concrete operational thought (Kelly, 1977; Laurendeau-Bendavid, 1977; Okonji, 1971; Owoc, 1973; Philp & Kelly, 1974; Stevenson et al., 1978). However, these studies did not examine the demographic characteristics of schooled and nonschooled groups. In view of this, one could argue that the effect of schooling was overestimated in the presence of many uncontrolled covarying factors.

A number of researchers have also commented that the developmental lag reported for nonschooled children may reflect defects in methodology rather than a slower rate of cognitive development (Kamara & Easley, 1977; Nyiti, 1976). When these defects in methodology were corrected, the differences between schooled and nonschooled children disappeared (Kiminyo, 1977; Nyiti, 1976). This finding has also been supported by several studies, which reported no direct relationship between schooling and cognition (de Lemos, 1969; Fahrmeier, 1978; Goodnow & Bethon, 1966; Mermelstein & Shulman, 1967; Pellufo, 1967; Price-Williams, 1962; Youniss & Dean , 1974).

On the basis of these studies, it is hard to draw any definite conclusion regarding the effects of schooling on cognitive development. While the performance differences, if any, between schooled and nonschooled children continue to be of interest, the existing studies are clearly divided on the issue. As has been suggested, a more precise answer to the question can be obtained in the context of cross-cultural research provided the methodological problems in the studies and sociodemographic differences between schooled and unschooled children are properly handled. The present study sought to examine the issue from this point of view.

C. Cognition and Schooling: Evidence from Experimental Research

The work of Cole and his colleagues (Cole et al., 1971; Cole & Scribner, 1974; Cole & Scribner, 1977; Gay & Cole, 1967) with the Kpelle of Liberia is based on an interactive approach between experimental psychology and ethnography. They studied not only the performance characteristics of the schooled, unschooled, and illiterate adult populations within the Kpelle culture, but also contrasted their performance with a group of Americal school children.The ethnographic analysis of the Kpelle culture guided them in making the tests on classification, learning, and memory appropriate to the Kpelle cultural contexts.

Classificatory Behavior

Cole et al. (1971) investigated the Kpelle classificatory behavior as a function of exposure to formal educational experience. In a classification task where the subject was required to sort twenty familiar objects into piles, education produced classification based on static taxonomic categories. The illiterate adults and children in grades 2 to 5 produced pair-based groupings on the functional properties of the stimuli. The Kpelle high-school students made semantically based groupings like the American schooled children in 1st and 2nd grades. Sharp et al. (1979) also found similar evidence in the Mexican culture. It appears that educational experience increases the application of taxonomic category information to the explicit organization of objects.

Several studies (Gay & Cole, 1967; Greenfield & Bruner, 1966; Sharp et al., 1979) investigated the classificatory behavior of the schooled and unschooled children in the presence of perceptually conflicting bases of information. Using a set of geometrical figures, which could be classified according to either form or size, Greenfield and Bruner (1966) found that schooled Wolof children in Senegal used form as the basis of sorting. In their studies on the Mexican culture, Sharp et al. (1979) found that educated subjects very often used form as the basis of sorting and that they shifted their basis of classification, if instructed to do so. The general trend emerging from these

studies is that years of educational experience influence the individual's ability to impose a classification scheme on stimuli with perceptually conflicting bases of information. Even when materials such as maize kernels of different colors and sizes, which are culturally familiar to the Mexican illiterates, were used as stimuli, the sorting performance of the uneducated subjects did not improve (Sharp et al., 1979). But this finding stands in sharp contrast to the results obtained from earlier experiments where Kpelle illiterate adults were compared with American subjects in sorting twelve leaves selected from vines and trees. The nonliterate Kpelle adult farmers outperformed their American counterparts in sorting the leaves of vines and trees into their respective groups.

The literature on education and cognitive development suggests two major lines of interpretation for discrepant results of this sort: one emphasizes the difference in the familiarity of stimulus materials; the other emphasizes differences in the way stimulus information is processed. Initially, Cole and his colleagues had explained many of the discrepant results of this sort in terms of a differential-familiarity hypothesis. In 1979, Cole and his associates (Sharp et al., 1979) carried out an extensive research on the rural Yucatan subjects in Mexico to determine the influence of education and age separately. In a free association task using nouns, verbs, and adjectives as stimuli they found that both the educated and uneducated

subjects gave paradigmatic responses when nouns were used as stimuli. But for adjectives and verbs, the more highly educated subjects responded paradigmatically more often than uneducated subjects. In interpreting these results Sharp et al. (1979) remark, "It is findings such as these that have made us skeptical that differences in lexical structure or stimulus familiarity is a general explanation for the education related differences observed in our studies" (p. 77).

Why should education affect associative responding? One line of interpretation given by Luria (1976) is that education increases paradigmatic responding through increases in vocabulary knowledge. Educational experiences increase the child's vocabulary and strengthens the basic semantic relations among words in his reportoire. Words that are simply familiar but infrequently encountered will not give rise to paradigmatic responding. The fact that uneducated subjects did not give paradigmatic responses to adjectives and verbs may still be meaningfully interpreted within the framework of a differential-familiarity hypothesis.

Recall and Clustering in Memory

The influence of schooling on learning and memory has also given rise to a substantial body of literature. The way in which the educated and uneducated subjects reorder stimuli in a free recall situation gives insight into the mechanisms of memory as influenced by education. In order to

study the influence of education on the nature of clustering in memory output, Cole et al. (1971) used a variety of verbal and non-verbal categorization techniques consisting of four semantically based classes (foods, tools, utensils, clothes) in Kpelle language. They also used a list of nonclusterable items for comparison. The Kpelle subjects from three age groups (6-8, 10-14, and 18-50 yrs.) were tested on this free recall task. Schooled and nonschooled children were compared in the two younger age groups. A group of American school children were also studied for cross-cultural comparison. The following were some of the major conclusions from their study: (a) the clusterable lists were learned more easily by both the educated and uneducated groups in Kpelle, and also by American school children, (b) the total number of items recalled by the educated subjects was significantly higher than that recalled by their uneducated counterparts, (c) the free recall score increased rapidly from trial 1 to 5 for the educated subjects, (d) sizeable clustering began at the sixth grade for the American school children while category clustering occured at the secondary level of education for the Kpelle subjects, and (e) when objects in stead of words were used in the experiment, there was no reliable difference between the educated and uneducated subjects in the average number of items recalled. But the clustering in recall differed slightly between the schooled and nonschooled groups.

In summarizing their results, Cole et al. (1971) concluded that secondary level education in Kpelle produces both qualitative and quantitative changes in recall. In a similar study on the schooled and unschooled children in rural Yucatan in Mexico, Sharp et al. (1979) also confirmed the above findings.

In order to explain the recall difference, Cole et al. (1971) examined whether nonschooled subjects lacked some 'general memory skills' or they could perform as well as the schooled subjects when given proper retrieval cues. Using twenty 10-14 year-old school children in what has been termed as the 'Chairs' experiment, they tried to make the experimental contexts more meaningful to Kpelle subjects. Twenty objects from four semantic classes (foods, tools, clothes, utensils) were presented one at a time above a specific chair in a group of four chairs facing the child. Half of the subjects were presented the objects from the same semantic category above the same chair (rule condition), while for the other half the objects were randomly presented over four chairs (random condition). The subjects were not instructed to recall either by chair or by category. It was found that the rule condition produced superior performance in terms of the average number of items recalled, and category clustering over trials. The results were also dramatic when all the items were presented above a single chair. Surprisingly, the 'single-chair' condition produced as good recall and clustering as the rule

condition. The experimenters remarked that "...something produced excellent recall in most of the studies using the chairs procedure" (p. 134). In general, the findings suggest that the availability of retrieval cues facilitates recall among the Kpelle schooled subjects. However, in the absence of a comparable group of nonschooled children in this study, the conclusion does not readily yield generalization for the effects of schooling.

Based upon the work of Tulving and Osler (1968), Cole and his associates followed the question of retrieval cue and hypothesized that verbal cuing both at the time of presentation and recall would be more effective in producing better recall and category clustering. They created five conditions in which the verbal cues relating to the semantically based classes used earlier were given at designated points in time during the experiment. The five conditions of the experiment were as follows: (a) cuing at both presentation and recall, (b) cuing at presentation but not at recall, (c) cuing at the time of recall but not during presentation, (d) no cuing at all, and (e) 'constrained recall' which was the same as condition (a) except that the subjects were asked to recall as many items as possible from a given category. Surprisingly, none of the cuing conditions was effective in producing higher recall or clustering. However, the 'constrained' recall condition produced slightly higher recall scores. Similar findings were obtained with the third and sixth graders in the United

States. Although the experiment did not demonstrate the utility of verbal cuing for nonschooled children, it was suggestive of many things in a number of ways. It was demonstrated that Kpelle children can show a level of memory abilities similar to that of Americans but under appropriate conditions of the administration of the task. Following this argument, Sharp et al. (1979) also demonstrated that less educated subjects in Mexico used semantic information to guide their responding in a memory task when the utility of doing so was explicitly demanded by the task at hand.

At this point, it seems clear that the use of familiar material may not necessarily guarantee the activation of cognitive potential of subjects. Dasen (1977) remarks that inferences about the presence or absence of certain cognitive abilities would be meaningful only when the operation called for by a given task is called into play within a given cultural milieu. The embedding of the to-be-learned materials in a context that has significance and meaning for the subjects is likely to enhance recall performance. When the 20 items used in the previous experiments were embedded within story contexts, the nonliterate adults could reliably reproduce the items. The main trend emerging from this set of studies is that educated subjects do not require specially structured presentations to organize their recall. They can spontaneously generate organizational strategies for the to-be-remembered materials. On the other hand, uneducated

subjects have not learned to spontaneouly produce such structures under as wide a set of circumstances. Hence, education-related effects will appear most strongly when the task allows but does not require the subject to apply his semantic knowledge.

Exactly such an effect was obtained in studies by Wagner in Mexico (Wagner, 1974) and in Morocco (Wagner, 1978). In a short-term memory task, using the probe recall paradigm, Wagner found that the educated subjects could spontaneously apply mnemonic strategies, especially rehearsal, which increased their primacy, and overall recall. Wagner was also concerned with the problem of studying process variables and used tasks wherein he could study memory processes, such as serial position effects. Following Atkinson and Shiffrin's (1968) model of memory which distinguishes between structural and control processes, Wagner (1978) attempted to study the influence of environmental events such as schooling and urbanization on the development of control processes. From his studies in Mexico and Morocco, Wagner (1974, 1978) provided evidence that schooling and urbanization may contribute independently to the development of control processes such as rehearsal and organizational strategies. Wagner (1981) noted that structural features remained invariant across ages, while control processes developed dramatically between about 4 to 14 years of age in Western school children.

The influence of urban environment on the cognitive competence of grade 5 Brahmin (upper-caste) and Harijan (lower-caste) children has also been documented in a study in Orissa, India (Das & Singha, 1975). The home environment of the Brahmin children is conducive for intellectual performance. In Harijan families, there is a relative lack of parental interest in children's education. Das & Singha (1975) did not find any difference in the cognitive abilities between poor Brahmin and Harijan children living in an urban area. The disadvantages of belonging to a Harijan family were greatly reduced by the enriched stimulations of the urban environment. Hence, in addition to schooling, an urban environment contributes positively to the development of cognitive abilities.

Recognition Memory

In addition to short-term recall, Wagner (1978) studied the influence of schooling on recognition memory. Developmental studies of recognition memory have often been characterized by a lack of age-related trends in performance (Brown, 1975), because the recognition memory task does not require the use of mnemonic strategies. But when the recognition memory task becomes increasingly complex, it requires the use of specific mnemonic devices and hence, the age- and education-related effects emerge with respect to performance on this task.

To investigate this hypothesis, Wagner (1978) conducted a study of recognition memory using Oriental rug patterns of

Morocco. Different levels of age, education, and urbanization were represented in the sample. Traditional Quoranic scholars who are known for their rote-memorizing capacity, Moroccan rug sellers, and a group of students from the University of Michigan were also included in the sample. The main findings of this study were: (a) chronological age did not produce any reliable effect, (b) schooling produced a significant effect, especially when there was a longer time-gap between the stimuli seen and the stimuli to be recognized, and (c) Quoranic students performed at a lower level, while the Moroccan rug sellers, rural subjects and University of Michigan students performed at a higher level. Because the rug sellers and the rural subjects were familiar with the rugs, they surpassed other groups in recognition memory . Quoranic scholars, showed poor memory performance and little use of strategies, because they lacked appropriate schema for spatially presented pictures, although they may be good memorizers for encoding Quoranic material. This study is suggestive of the fact that one needs to be careful in generalizing about the availability of cognitive skills in different populations.

In general, Wagner (1978) demonstrated that schooling and urbanization may considerably influence the development of control processes in memory, while leaving the structural aspects unaffected. It may be noted that Wagner was making explicit inferences about underlying cognitive processes from outcomes on cognitive tasks; this is a problem not

unique to cross-cultural research only, but pervades a variety of psychological researches.

Memory and Task Contexts

It has been noted that memory performance is a function of the nature of stimuli, and the manner in which a task is presented. Cole et al. (1971) also found that nonschooled Kpelle subjects demonstrated category clustering in 'constrained' recall but not in free recall situations. The use of standard taxonomic categories sharply delimits the nonschooled children's ability to use category clustering for improved recall. In pursuing this hypothesis, Scribner (1974) decided to investigate how these subjects might exhibit the use of category structures when they are allowed to make up their own taxonomic categories. Twenty five items were presented to the subjects who were asked to group the items using their own criteria. After the criterion of identical category sorts on two consecutive trials was reached, all the items were covered up, and subjects were instructed to recall the items. The major finding was that the schooled and nonschooled subjects made use of their own groupings to cluster recall (Cole & Scribner, 1977). However, the experiment did not take any precaution to neutralize the effect of practice. The findings would have been more meaningful, if groups of schooled and unschooled subjects would have been asked to recall the items first followed by a request to group the objects into piles. Then one could have examined if the pattern of clustering

exhibited in free recall was also witnessed in their sorting performance.

It has been pointed out that the nature of stimuli and the manner of stimulus presentation may considerably influence the performance differences between schooled and nonschooled populations. Following Bruner's (1966) distinction between enactive, iconic, and symbolic modes of representing experience, it can be said that nonschooled children rarely represent their experiences in a symbolic mode, while the schooled children often do so. Stevenson et al. (1978) explored this issue by using different types of memory and cognitive tasks on the assumption that environment and schooling would have differential effects on memory and cognition depending upon the mode in which stimuli are presented. In their research with Peruvian children, Stevenson et al. (1978) presented memory tasks in verbal, pictorial, and enactive modes, while cognitive tasks were given in concrete and abstract versions. The expectation that the version of the task would interact with schooling received little support. Schooled children outperformed their unschooled counterparts on all the tasks regardless of the mode of presentation. Stevenson et al. (1978) distinguished three aspects of performance affected by attendance at school: level of performance on memory and cognitive tasks, variability within groups of children, and differentiation of performance within the child. Schooling had the effect of reducing differences among children in

tasks dependent on short-term memory, ability to follow instructions, and ability to analyze visual details. Several other researchers have also substantiated the positive influence of education on short-term memory (Wagner, 1974), and ability to follow instructions (Scribner & Cole, 1978a). The study by Scribner and Cole (1978a) on the Vai literates in Liberia also reported that the Vai script was associated with improved ability to follow instructions and analyze the details of speech. In accounting for the effects of schooling, Stevenson et al. (1978) also gave a similar interpretation. They noted that the formal didactic setting of the school helps children learn certain specific skills such as attending to and carrying out instructions, encoding experiences into words, and decoding pictorially represented stimuli.

The presence of a substantial amount of within-group variability for a number of memory and cognitive tasks in Stevenson's study raises serious questions about the concept of generalized structure of abilities that are applicable to all children attending school. Schooling did not neutralize the effects of environmental differences. The children from rural and urban environments, and from differing cultures and social classes benefited from attending school, so that the preexisting differences between groups were not wiped out by schooling. It may be noted that this study included 5 and 6 year olds; some of the 6 year-olds attended school for only one year, which may not be enough to show the effects

of schooling. Greenfield, in her critique of Stevenson's research remarks that the effect of one year of schooling might be limited to two areas: the tendency to complete a test, and visual analysis and reproduction. Thus, while some studies show the effect of schooling on memory and related processes, it seems that a minimum number of years of schooling may be necessary for the effect to be significant.

Response to Verbal-Logical Problems

Whether or not industrialized and traditional people share the same basic pattern of logical processes has become a matter of considerable concern for the cross-cultural investigators. Following Levy-Bruhl's (1966) characterization of the primitive mentality as 'prelogical', this issue took a specific form of examining whether the processes of inference in verbal thinking is universal across cultures. A number of cross-cultural psychologists have made use of syllogisms and other forms of formal logical problems to investigate the verbal-logical processes of the 'traditional' and Western people.

Research carried out by Luria (1971) with the peasants of Central Asia indicates that relatively low levels of education can influence subjects' mode of responding to verbal-logical problems. Inspired by Vygotsky's theory of cognitive development that characteristics of complex intellectual operations are determined by the socio-historical experiences, Luria sought to investigate the influence of minimal literacy training on solving

verbal-logical problems. Remarkable differences in the performance level of groups with minimal literacy training versus those with no training at all led Luria to believe that even low levels of education will change the fundamental structure of cognitive processes. The positive influence of education on syllogistic reasoning has also been documented in several studies (Cole et al., 1971; Fobih, 1979; Luria, 1976; Scribner, 1975; Sharp et al., 1979). When the pattern of questioning was changed so that nonschooled elders were asked to judge the validity of logical conclusions in a group discussion setting, they had relatively less difficulty (Cole et al., 1971). When the illiterate adults were asked individually to draw conclusions from stated premises, their performance characteristics were similar to that observed by Luria (1971).

The consistency of findings related to performance on the Syllogistic Reasoning Test is impressive. However, the basis for the performance superiority of schooled children is by no means clear. Following Luria's research and Vygotsky's theory of mental processes, it appears reasonable to believe that there would be a large amount of between-culture variation in syllogistic performance, as different cultures provide different conditions of social and practical activity to its individual members. The striking similarity in both qualitative and quantitative results obtained with nonliterate people across different

cultures suggests that it is not the specific cultural experiences per se, but the exposure to formal educational experience, which is crucial for solving verbal-logical problems. It should be noted here that the performance characteristics of Central Asian peasants or Mexican or Liberian nonliterates may not be universal, and caution must be exercised in drawing similar conclusions regarding the thought processes of nonliterate populations in other cultures.

In another study, Fobih (1979) argues that that it is not schooling per se, but the quality of educational experience which is important for solving verbal-logical tasks. Does this imply that the nonliterate people do not reason logically? Even minimal familiarity with daily life situations of the traditional people makes such a hypothesis untenable, as they do skillfully assimilate their community experience and accomodate to the environmental demands in a manner that is necessary for their survival. Assuming that the verbal-logical process is a fundamental aspect of cognition (Luria, 1971), it is hard to reconcile to thè fact that this process can undergo a radical change as a result of only 6-12 months of literacy training.

Would this then be due to the fact that the nonliterates are not poorer in logical reasoning, but they fail to apply their logical skills to verbal materials? Although, this hypothesis seems to be reasonable, it does not explain fully the inferior performance of illiterates.

The analysis of the protocols of some illiterate subjects indicates that they were capable of inferential reasoning in the verbal mode. The problem, however, was that their reasoning process was largely shaped by their own personal normative knowledge, rather than the verbal-logical relations existing within the problem. Illiterates do not treat the problems in the same manner as the experimenter expects them to do. Rather, they bring in their past experiences, which dictate their answer to a problem. In other words, they do not treat the problem as a self-contained logical unit, which needs to be answered only in the context of the information presented within the problem. Therefore, the source of difficulty may not be in terms of logical reasoning, but rather in not being able to carry on a context-independent form of thinking. If the problem can be posed in a manner that they would be willing to treat it as a logical unit, they would probably show the same logicality as do schooled subjects.

Because schooled children have acquired a formalized linguistic system, their response to verbal-logical problems is no longer determined by the particular contents of the problem, but by the verbal-logical relations of the problem-premises. Unlike illiterates, schooled children give justifications for their answers with reference to the information contained in the problem. Scribner (1976) terms these answers 'theoretic', as opposed to 'empiric' responses, which are based on information external to the

problem, and in most cases dictated by subjects' past experiences.

However, it is difficult to separate 'theoretic' and 'empiric' responses for all types of syllogisms. For example, consider the syllogism, "Wherever it snows, the color of the bears is white; it snows in Vladivostok; what colors are the bears there?" Suppose a subject responds "white", and when asked for justification, says "because it snows." Does this imply that the subject gave a theoretic response? It may as well be that the subject derived the solution from his past knowledge. He may have heard about the color of the bears in Vladivostok from one of his friends, or may have reasoned that snow would be all over the body of the bear giving an apparent sense of white color. If the subject is a schooled child, he may have read about the color of the bears in Vladivostok. So an elaborate form of verbal exposition would be necessary before a response could be judged 'theoretic', in which case those lacking facility in verbal expression, like the illiterates and nonschooled, would be at a disadvantage. Then the syllogistic reasoning task would take the form of an assessment of linguistic skills rather than logical reasoning.

Consider another example: "Cotton grows where it is hot and humid; in the village it is hot and humid; does cotton grow there or not?" A subject may respond "yes", and justify his answer by saying "because it is hot and humid." Does it

represent a theoretic or empiric response? From this short verbal exposition, it is difficult to judge if the subject was engaged in a process of verbal-logical deduction. It is possible that the subject may have given this response purely on the basis of his personal knowledge about what should be the right temperature for cotton to grow. Thus, for all types of syllogisms, it is not always possible to make a clear distinction between 'theoretic' and 'empiric' responses, although such a distinction might be relatively easy for classical syllogisms of the type, "All men are mortal; all kings are men; are they mortal?"

A perfect theoretic response to a verbal-logical problem would be one, wherein the subject repeats the major and minor premises back to the experimenter, and states the conclusion with an additional comment, "because you said so." Previous investigations (Luria, 1976, Scribner, 1977) indicate that many nonschooled children have difficulty in repeating syllogisms. Thus a failure to give a theoretic response may indicate subjects' inability to retain the premises in memory, rather than an inability to respond to the logical relations within the premises. That is why a semi-experimental and semi-interview format of administering the syllogistic problems has always been emphasized in the literature.

The analysis of some recall protocols of Russian peasants (Luria, 1976) suggests that there was considerable disagreement between the experimenter and the subject with

regard to what should be accepted as truth. While the experimenter insists on a verbal-logical inference related to the premise-relations, the subject believes that conclusions should be based on his practical knowledge of the world. Rogoff (1981) remarks, "The subject insists that the truth should be based on first-hand knowledge, or perhaps on the word of a reliable, experienced person. He obviously does not include the experimenter in the latter category, either because the experimenter does not claim to have had the experience himself of verifying the color of the bears, or because the experimenter is not considered an authority"(p. 254).

Let us now turn to the problem which asked about the color of the bears in the far north. When a subject was probed with regard to his justification for the answer, he refused to cooperate with the experimenter in the process of verbal-logical deduction by replying "What the cock knows, how to do, he does. What I know, I say, and nothing beyond that." Such a conversation reflects a gap between the subject and the experimenter, and indicates the subject's unwillingness to accept the experimenter as an authority. Rogoff (1981) also cites a personal communication by Triandis, where it is pointed out that "the peasants' replies may also reflect a conflict between Russians and Central Asians, who were conquered by Russians" (p. 254). This type of response pattern may not be witnessed in all cultures, and therefore, caution should be excercised in

interpreting these recall protocols as evidence of poor verbal-logical reasoning ability. Luria himself also observed the excellent inferencing skills of illiterates in problems related to the practical life situations in their community.

Olson (1977b) commented on what should be taken as evidence of logical thinking. If logical thinking refers to drawing conclusions from stated premises in a manner congruent with experimenter's expectations, then judgments based on subjects' personal normative knowledge would be an evidence of illogical reasoning. On the other hand, if logical reasoning is defined as applying certain mental operations on the premises as they have been personally interpreted, then importation of personal experience to draw a conclusion should be evaluated as perfect logical thinking.

What processes are involved in syllogistic reasoning? How does performance on verbal-logical problems relate to simultaneous and successive coding processes? Although cross-cultural investigators have identified the sources of difficulty for the poorer performance of nonschooled subjects, they have not explained the mechanisms underlying verbal-logical performance. In solving syllogisms, the subject encodes the linguistic information of the problem into a mental representation, which is then followed by an attempt to draw inferences from this representation (Falmagne, 1975). Thus the first stage involves encoding of

the problem premises, and the second one consists of applying a mental operation on the encoded information (Evans, 1972). For a correct solution, the encoding of the linguistic information involves an internalization of the fact that the premises belong together, not as entities which are independent of each other. So far as the linguistic analyis of the syntactic nature of the problems are concerned, it conforms closely to the characteristics of successive processing (Das, Cummins, Kirby, & Jarman, 1979). However, the subject is required not only to examine the premises, but also to attend to the relationships that exist among them in order to make a valid inference. Hence, the task demands relational thinking, which is a characteristic of simultaneous processing.

Bickersteth and Das (1981) noted: "Both spatial arrangement of the premises and their linguistic analysis are necessary for correct solution... The metacognitive processes which subsume these are simultaneous and successive, the two basic coding processes, which are posited by Luria (1966), and operationalized by Das and his students" (p.2). Consistent with their prediction, Bickersteth and Das (1981) observed that both coding processes were essential for solving syllogisms. Their finding was also supported by Johnson-Laird's (1978) observation that syllogistic reasoning requires both spatial and linguistic processes. However, as pointed out by Bickersteth & Das (1981), the involvement of both processes

depends to a large extent on the level of educational experience of the sample.

Discussion of the Major Findings

In their ethnographic analysis of the Kpelle culture, Gay and Cole (1967) remark that in Kpelle culture there is no argument over the facts of the case, and it is not necessary that a point be logically sound. An argument is won when it is unanswered. However, one can argue that the same also happens in Western culture. Labov (1970) even goes to the extent of saying "that in many ways working-class speakers are more effective narrators, reasoners, and debaters than many middle-class speakers, who temporize, qualify and lose their arguments in a mass of irrelevant detail" (p. 164). Obviously, here Labov has made explicit reference to the middle-class speakers in Western cultures. Western researchers may not always be able to detect the logical course of thought processes in traditional societies because of their unfamiliarity with the cultural contexts in which the communications of the primitive people take place. Cole et al. (1971) were aware of this problem while making an ethnographic analysis of the Kpelle culture.

The contexts in which uneducated and illiterate subjects apply their problem-solving strategies are different from the ones for educated subjects. The tasks given to nonschooled subjects need to be ecologicaly valid before any meaningful inferences can be drawn about their cognitive characteristics from their performance on these

tasks. The use of familiar stimuli, considered to be a basic minimum, does not necessarily provide a context which would activate the use of appropriate strategies in the uneducated subjects. An uneducated boy who can recall the names of all his fellow villagers, can sort the leaves from vines and trees, and can give an account of all the happenings in his village for the last decade, fails to recall twenty familiar items in the experimental situation. It may be quite possible that he is able to adopt strategies in solving problems, but fails to see the applicability of those same strategies in the experimental tasks. In sorting, and free recall tasks, American school children reflect an implicit recognition of the experimenter's demand for static taxonomic categories, while the nonschooled Kpelle, and Mexican children fail to recognize what is required of them. When the to-be-learned items are embedded in story contexts, the Kpelle illiterate adults and nonschooled children show evidence of better recall and higher clustering. During the constrained recall situation, where the utility of using semantic information is built into the tasks, less educated subjects also profit from knowledge of the category structure.

The general issue here is related to a distinction between performance and competence. Based on Flavell's (1970) distinction between production and mediation deficiency, cross-cultural researchers have suggested that 'production deficiency' may be an appropriate way to view

the lower memory performance of certain groups, especially nonschooled and illiterate people (Cole & Scribner, 1977). The term 'production deficiency' has also been used to characterize the performance of the educable mentally retarded children (Brown, 1977). Obviously there should be some way to distinguish the performance of educable mentally retarded children and that of nonschooled Liberian and Mexican children. Wagner (1981) notes that the deficiency to produce strategic behavior may be of a superficial nature or may require constant intervention for maintenance of behavior. Uneducated subjects exhibit a kind of 'production deficiency' which can be easily and permanently overcome through training, task reformulation, and contextual change (Wagner, 1981).

Besides stimulus familiarity and the ecological validity of the tasks, the language in which testing is carried out, and the specific nature of instruction also deserve considerable attention. In their research in Peru, Stevenson et al. (1978) tested Quechua children in Spanish which was a second language for them. The language difference raised a potential alternative hypothesis for interpreting the performance differences between Quechua and Mestizo culture on tasks where language skills were most critical. Furthermore, the specific way, the instructions are given, considerably influences the response patterns of the educated subjects, while its effect is minimal for the uneducated group. Sharp et al. (1979), and Scribner and Cole

(1978a) found that education promotes sensitivity to following instructions. In cases where the task is structured and 'tells' the subject what to do, less educated subjects perform considerably better. If the task is open ended, an uneducated person is not able to determine which of the available competencies to use. However, this explanation is true only for laboratory-based tasks. It may not be true for the intellectual performance of uneducated subjects in general. Tasks pertaining to the real life experiences of uneducated subjects may require less task-structure to call for the appropriate cognitive operations.

Researchers have always tried to take care of the problem of sampling bias in the selection of schooled and unschooled children. Students at the secondary level of education have survived 7 to 8 years of schooling and are thus more intelligent compared to their unschooled age-mates. Hence the results of comparing these two samples would reflect a confounding effect of schooling and levels of intelligence. It is desirable to establish through sociodemographic survey that in a particular environmental set up, IQ was not playing any role in the selection of children for schooling. Sharp et al. (1979) conducted a sociodemographic survey and tried to determine the effect of IQ on the grade level of subject by regression analyses. Their IQ measure was simply based on a subscale of the WAIS, which was again not standardized.

The years of schooling may not be a good measure of complex experiences that occur in school. It is not the schooling per se that activates cognitive skills, but the activities that children undergo when in school. Pollnac and Jahn (1976) carried a study on taxonomic clustering behaviors of Ugandan children in public and religious schools. The religious school required children to recite long prayers, and was thus fostering a schema for encoding and retrieving verbal material. The outcome of the study was that the religious school children exhibited clustering and higher recall, while little clustering was evidenced in the recall protocol of children in other schools. Other studies of religious schools (Wagner, 1978; Scribner & cole, 1978a) did not find such an effect. However, the research evidence suggests that there is a need to study school ecology and the activities taking place in the school in order to examine the effects of schooling. While most of the researches in the field suggest that schooling affects certain types of cognitive skills in specific ways, one needs to look at the processes of schooling itself in order to fully understand its mechanisms of influence.

As pointed out earlier, in general schooling facilitates aspects of children's cognitive growth through certain mechanisms such as helping children to think in a context-independent manner, and emphasizing a verbal mode of instruction. The school also emphasizes the need to search for general rules in order to coordinate specific instances

of learning into an integrated system of thinking (Scribner & Cole, 1978a). Besides, schooling also seems to facilitate specific task-related strategies like ability to follow instructions, analyzing visual details, rehearsal strategies for memory, and so on.

There have been some claims that one of the reasons for all these impacts of schooling on cognitive processes lies in its emphasis on a written form of language. Written language provides new modes of thought to the schooled children, and this may account for their superiority over nonschooled children with respect to cognitive test performance. The new adult literates who have gone through recent literacy programs throughout the world have also acquired similar skills in writing, which may also facilitate their cognitive processes in the same manner as does schooling.

D. Cognitive Consequences of Literacy

A variety of claims have been made about the relationship between literacy and cognitive competence. The two dominant perspectives guiding this area of research are labeled by Scribner & Cole (1978a) as the 'developmental' perspective and the 'practice' perspective.

The developmental perspective suggests that literacy develops mental capacities which have widespread intellectual consequences, while the practice perspective proposes that literacy only helps develop certain specific

cognitive skills which may or may not be important for functioning within society in general.

Developmental Perspective

Greenfield (1972) argues that written speech is at a higher level of abstraction than oral speech which is a context-dependent language. Written language requires that meaning be made clear, independent of the immediate and concrete reference. Written language provides the means for decontextualized abstract thinking.

The invention of literacy had profound cognitive effects on the course of human history. Goody & Watt (1968) suggest that the mastery of phonetic writing system in Greece in the early years of human history was instrumental for the emergence of two new forms of human intellectual endeavour: the origin of history as distinct from myth and the founding of formal logic. The characteristics of written language facilitated the development of analytical modes of thought. With the help of written records the importance of memory also decreased. The potentialities of the alphabetic script as a new instrument of communication affected the whole range of human activities, political, economic, legal, and religious. With the invention of writing, came the need to remember information word-for-word and then checking recall against the written records. Examination of inconsistencies in statements became possible when written records replaced the oral accounts, and Geek citizens became more conscious, comparative, and analytical of historical

and theological accounts. The difficulties in planning future course of action was greatly reduced. Literate modes of thought opened up new avenues for human intellect and for the transmission of knowledge from one generation to another.

In considering the intellectual effects of literacy, a distinction must be made between its effect on societies and on the individual. Literacy, undoubtedly contributes to the advancement of societies. But how does the exposure to reading and writing experiences influence the intellectual capacities of an individual? Luria's work (1971) on illiterate peasants in Central Asia suggests that the mental operations of illiterate villagers were confined to the immediate, the concrete, and the practical, and had little reference to abstract and categorical associations. Their responses to syllogisms which call for decontextualized experiences were guided merely by their real life experiences. They attended to the particular contents of the problem and not to the verbal-logical relations existing within the problem. Similar findings have also been reported by Cole et al. (1971) in their research on illiterate and literate adults in Liberia. Greenfield (1966) remarks: "linguistic contexts can be turned upside down more easily than real ones. Once thought is freed from concrete situation the way is clear for symbolic manipulation... in which the real becomes but a set of possible"(p.175).

Olson (1976, 1977a,b) believes that literacy and education enhance cognitive growth. The mastery of logical functions is linked to literacy. According to Olson, many of the cognitive changes observed in the early school years are due to familiarity gained with literacy at that stage.

Writing experiences are considered to have a profound effect on the thoughts of those who use this tool, transforming not only their written thinking, but also their treatment of oral language by transfer of literate mode of thought. Scribner & Cole (1978a) characterize the viewpoints of Greenfield, Bruner, and Olson as representing a developmental perspective. A defining characteristic of the developmental perspective is that it specifies literacy's effects as the emergence of abstract thinking and logical operations rather than specific skills. Scribner & Cole criticize this perspective on two grounds: (a) it does not distinguish between the intellectual effects produced by schooled and nonschooled literacy; (b) it assumes that literacy is likely to have the same psychological consequences in all cultures irrespective of the context of its use and the social institutions in which it is embedded.

Practice Perspective

Scribner and Cole (1978a,b, 1981) tested for the intellectual effects of literacy apart from that of schooling. They were primarily interested in a functional analysis of literacy. They remark: " the assumption that logicality is in the text and the text is in the school can

lead to a serious underestimation of the cognitive skills involved in nonschool, non-essay writing, and reciprocally, to an overestimation of the intellectual skills that the essayist text 'necessarily' entails"(Scribner & Cole, 1978b, p.24).

Scribner & Cole examined the intellectual activities of Vai people on the northwest coast of Liberia. The Vai belong to a traditional nonschool-going society with an indigeneous writing system. Some Vai individuals are literate in Arabic and some in English. English is the official national language and is learned in Western-type schools; Arabic is the religious script and is learned in traditional Quranic schools emphasizing the rote memorization or reading aloud of passages from religious books without comprehending their meaning. Vai script is used for the majority of personal and public needs in villages.

The nonschooled Vai literates and nonliterates were compared for their performance on classification and verbal reasoning tasks which are thought to be particularly sensitive to school-based learning. Vai literates were not significantly different from nonliterates on any of these measures. So the authors moved down one level of generality in the kinds of hypotheses tested; they proceeded to examine the component skills involved in literacy.

They used a communication task where the subject was required to dictate a letter describing a board game to one of their distant friends. The performance of the Vai

literates was superior to that of the Arabic literates and nonliterates. In dictating the letter, the literates first addressed the informational needs of the reader; this Scribner & Cole called as an example of contextualization of information.

Scribner and Cole also used a memory task wherein the subject was required to learn an ordered string of words, with one more word being added to the list on each trial. Since this is the way the Quoran is learned, they reasoned that the Arabic literates would be superior to Vai literates and nonliterates. Indeed, their hypothesis was confirmed for this particular memory task. But in other memory tasks (Scribner & Cole, 1978a; Wagner, 1978), Arabic literates showed no superiority in performance over Vai literates and nonliterates, thus suggesting a very specific transfer of learning rather than a general transfer.

In another set of studies, these authors tested the transfer of skills needed to read Vai texts. Since Vai script is written without word division, they suspected that Vai literates might have skills in language analysis and integration of syllables into meaningful units. They gave a listening task in which each person listened to tape recordings of meaningful Vai sentences. Sentences were broken either into word units or syllable units and were presented at a slow rate. The Vai literates were better than nonliterates and Arabic literates in repeating and comprehending the sentences with syllabic units. No such

difference was obtained for sentences which were broken down to word units.

The results of their study suggested that the Vai literacy was associated with certain specific skills such as analyzing oral speech and giving clearer instructions. The components of reading and writing may in fact promote very specific language-processing and cognitive skills. Scribner & Cole(1978b) note: "Nothing in our data would support the statement ... that reading and writing entail fundamental 'cognitive restructurings' that control intellectual performance in all domains. Quite the contrary, the very specificity of the effects suggests that they may be closely tied to performance parameters of a limited set of tasks" (1978, pp.36-37).

The authors suggest the need to test literacy distinct from schooling experience and to make functional analyses of how literacy is used outside of schools. Specific activities promote specific skills; with increased practice under varying conditions and with a variety of materials, skills involved in literacy become increasingly free from the specific conditions of the original practice. Following these suggestions, this study proposes to examine the intellectual effects of literacy in India.

As a whole, the review of literature on effects of schooling and literacy suggests a few problems and some general directions in this field of research. Generally, schooling has been shown to consistently facilitate

performance on certain memory and problem solving tasks. In regard to Piagetian tasks, this consistency, however, is much less obvious. It seems that the effects of schooling may vary from task to task, depending on the cultural context in which schooling takes place. Several studies reviewed suffer from some methodological problems such as test bias and selection bias, which have been described earlier. In considering the specific mechanisms of schooling, various explanations have been proposed. Schooling has been viewed as deriving its influence from its emphasis on the written mode of language. In this case, one can expect the effects of schooling and literacy to be qualitatively the same. On the other hand, there are others who view schooling to be more general in its effect and thus distinguish between schooling and literacy with respect to their intellectual consequences. The present study sought to address itself to some of these issues by comparing schooled and nonschooled children in one study, and literate and illiterate adults in another, within the cultural context of Orissa, India.

III. STUDY ONE

This section presents a rationale for the study, its major objectives, the considerations that guided the selection of tasks, its major hypotheses, the sample and its demographic characteristics, a description of tests, the data collection procedure, and finally the results and discussion pertaining to the cognitive consequences of schooling.

A Rationale for the Study

A large number of studies relating schooling to cognition were not motivated by any theoretical perspectives leading to in-depth exploration of cognitive processes but rather by an interest in trying out standard psychological tasks in other cultures (Rogoff, 1981). Piaget (1976) points out the limitations of this perspective: " To explain a psychological reaction or a cognitive mechanism ... is not simply to describe it, but to comprehend the processes by which it is formed. Failing that one can but note results without grasping their meaning"(p. vi).

Recently there has been a shift from the study of abilities to an enquiry into processes (Das, Kirby, & Jarman, 1975, 1979; Messick, 1973). Scribner & Cole (1973) have also emhasized the need to understand how learning and thinking skills develop in an individual member of the society, and how educational processes contribute to the shaping of cognitive skills. Unlike the study of mental abilities, the process approach to the study of cognition

emphasizes the manner in which an individual processes information, while solving a particular task. The process perspective does not deny the existence of abilities or capacities but rather suggests that an abilities perspective may not be meaningful in all situations. Furthermore, an understanding of processes by which individuals solve a particular task provides a knowledge of how they can be trained to do them more successfully, and how educational programs can be better designed to cater to individual differences.

The present study aligned itself with a process-oriented approach and attempted to study the cognitive consequences of schooling in the context of how efficiently schooled children integrate information compared to their nonschooled counterparts. The term 'cognitve process' in the present study derives its connotation from the information-processing model advanced by Das, Kirby, & Jarman (1975, 1979). This model as well as the tasks have been described in detail in the review of literature. The rationale for using this model for the study of cognitive processes of schooled children has also been provided. In summary, this study attempted to examine the development of coding and planning processes as a function of age and schooling experience in a cross-sectional design.

Apart from the process approach to the study of schooling and cognition, the question that has plagued researchers in the field is whether or not schooling

produces generalized cognitive skills. As has been mentioned earlier, schooling experience produces context-independent thinking, an ability to generalize problem-solving strategies within a selected range of psychological tasks, and an ability to follow instructions in the verbal mode. Do these skills have applications in important nonschool settings?

Language is the predominant mode of transmitting and acquiring information in school. Thus teaching and learning can occur without explicit reference to natural contexts. Compare this with the source of information available to a child who learns to do things by observing his father or an adult member of his group. The latter one is an example of informal education which is primarily based on observational learning (Scribner & Cole, 1973). Informal learning occurs in real situations where the meaning is intrinsic to the context; hence, there is little need on the part of the adult model to provide a detailed verbal formulation of a particular practice for the child. The school child lacks this opportunity for observational learning. The school's knowledge-base, value systems, and the learning conditions are discontinuous with those of the child's traditional culture. If the nonschool children belong to a culture where a wide variety of tasks are learned by observation, it would be reasonable to expect that they would possess special skills in observational learning compared to schooled children.

In nonschool settings, the child participates in the demonstration of a particular event for a number of times. Then he acquires a generalized way of performing that activity even though he may not be able to give a precise verbal formulation of that activity. In the school, the learning of a concept begins with a verbal formulation of a general rule. Over the course of time the student connects this general rule with empirical referents. So it is not surprising to find that school children give a more adequate description of the rules of a problem solution than do their nonschooled counterparts (Scribner & Cole, 1973).

Children in school have little time for the freedom needed for autoregulating experiences which, according to Piaget, are crucial in the development of conservation. Conversely, they are taught ready made rules to deal with their environmental problems rather than learning them through acting on the environmental problems.

In the light of this evidence it would be meaningful to assess the performance of schooled and nonschooled children on Piagetian tasks which are presumably measures of basic cognitive processes. In Piaget's stage-invariant theory the stages are assumed to reflect maturational changes in forms of thinking, and the gradual acquisition of concepts reflects the influence of physical and social environment. Piaget's theory provides a suitable model for studying the 'cognitive universals'. Since, Piagetian tasks are well suited for cross-cultural variations, and are less biased in

favor of schooled population, it was of interest to examine how schooling influences the emergence of thinking corresponding to the Piagetian stages of intelligence.

On the basis of earlier research work (Cole et al., 1971; Sharp et al., 1979; Stevenson et al., 1978), the present study also proposed to use certain cognitive tasks which measure some test skills thought to be promoted by schooling experience. Because of school's emphasis on verbal modes of instruction, context-independent thinking, and the search for universal principles, it was expected that schooled children would perform better on tasks which call for these skills. It seemed reasonable to expect that the differences between schooled and nonschooled children on this set of tasks would be wider compared to their difference on Piagetian tasks.

Furthermore, the information relating to major sociodemographic characteristics of schooled and nonschooled groups were also obtained. In many studies discussed earlier, schooled and nonschooled groups were matched in terms of age. The information regarding other sociodemographic variables (parental income, education, and occupation; family size and educational level) was not obtained. It is therefore likely that some of the apparent effects of schooling might have arisen due to a number of covarying factors instead. Consequently, the influence of schooling on cognitive test performance might have been overestimated. Hence, this study proposed to obtain

information with respect to the sociodemographic characteristics of schooled and nonschooled groups.

In summary, the objectives of the present study were:

1. To examine the effect of age and schooling on the development of coding and planning processes within the theoretical framework of the information-integration model proposed by Das et al. (1975, 1979) and Ashman (1978).
2. To determine the pattern of relationships among simultaneous, successive and planning processes as a function of age and schooling experience.
3. To examine the influence of schooling and age on concrete operational thinking as measured by Piagetian tasks.
4. To examine the role of age and schooling on the development of certain cognitive skills namely verbal-logical reasoning, memory, and retrieval strategies.
5. To relate simultaneous and successive processes to the performance characteristics on Piagetian tasks, and the above-mentioned specific cognitive skills.

Choice of Tasks

The study proposed to examine the development of coding and planning processes as a function of schooling experience. In addition, the study attempted to examine the cognitive consequences of schooling by comparing the performance of schooled and nonschooled groups on Piagetian

tasks of concrete operational thinking, and on laboratory-derived tasks which are presumed to measure the specific changes in cognitive abilities brought out by schooling. Accordingly, the tasks have been selected, where it would be possible to study the coding and planning processes, the use of strategic behavior, and the basic cognitive mechanisms as reflected in Piagetian tasks of concrete operational thinking. The following considerations guided the selection of the tests for this study.

1. The tasks which have been established as valid measures of coding and planning processes in the information-integration model (Ashman, 1978; Das, Kirby & Jarman, 1975, 1979) were used. Accordingly, Figure Copying and Memory for Designs (simultaneous marker tests), Auditory Serial Recall and Digit Span (successive marker tests), and Visual Search and Trail Making (planning marker tests) were chosen to be used in this study.
2. The two marker tests of planning (Visual Search and Trail-Making) are scored for time. In order to show that these time measures are not related to the 'speed of processing', but to a factor called 'planning', the inclusion of a test measuring speed of processing was considered desirable. Hence, the Color Naming Test was included in the test battery as a marker test for speed of processing.
3. The inclusion of the Word Reading Test was considered

necessary to examine if the schooled children were reading words at their respective grade levels. This test was given only to the schooled children.

4. The Piagetian concrete operational tasks were given only to subsamples of schooled and nonschooled children. The inclusion of these tasks were considered necessary as they tap certain fundamental aspects of cognition and reflect a more general pattern of thinking acoording to Piagetian theory.
5. Since this study also proposed to examine the influence of schooling on some memory and problem solving skills, some tasks measuring these skills were also included. The Syllogistic Reasoning task reflects context-independent thinking; the Clustering in Free Recall and Serial Short-Term Recall illustrate the use of strategic behavior in retrieval and memory strategies. These tasks tap very well some cognitive abilities which are presumably influenced by schooling experience.

Major Hypotheses

It is difficult to formulate specific hypothesis for each group and each cognitive skill under investigation. However, certain directions in the results can be specified.

Hypothesis 1

Since the methodological requirements of some earlier studies were satisfied, it is expected that the present findings would be similar to those obtained in

African studies (Kamara & Easley, 1977; Kiminyo, 1977; Nyiti, 1976), which have reported no direct relationship betwen schooling and concrete operational thinking. In other words, while performance on Piagetian tasks would improve as a function of age, there would be no differences in the developmental changes between schooled and nonschooled groups.

Hypothesis 2

On the basis of findings of earlier studies (Das, Kirby, & Jarman, 1975, 1979; Jarman, 1975; Kirby, 1976), it is expected that factors identifiable as simultaneous and successive syntheses would emerge for all the groups. The 'planning' factor is not expected for the nonschooled groups. However, the emergence of a 'planning' factor is possible for the 10-12 year old schooled (Grade 5) children.

Hypothesis 3

Simultaneous and successive syntheses have been found to be related to reading and writing experiences, and verbal comprehension (Cummins & Das, 1978), which are presumably fostered in the first few years of schooling. While both these coding processes are related to intitial reading performance, gradually simultaneous processing becomes relatively more important for reading and comprehending at an advanced level. It is hypothesized that for both coding processes, significant effects of schooling, and age would be obtained. It is

expected that through successive years of schooling, the differences between schooled children and comparable age groups of nonschooled children would be increasingly wider, suggesting that there would be an interactive effect of schooling and age on the development of these processes.

Hypothesis 4

On the basis of earlier findings (Cole et al., 1971; Sharp et al., 1979), it is expected that there would be no significant difference between schooled and nonschooled children in the spontaneous clustering of their recall output. However, schooled children might show increased clustering as a result of verbal cuing, where the experimenter tells the category names both at the time of presentation and recall.

Hypothesis 5

The overall memory proficiency as measured by Serial Short-Term Recall of Locations would improve as a function of age and schooling experience. Recency recall, which has been regarded as a measure of structural features in memory would remain unaffected by age and schooling exeprience. On the other hand, primacy recall, which is a measure of control processes in memory and is closely linked to verbally mediated rehearsal strategies is expected to improve as a function of both age and schooling experience.

Hypothesis 6

On the basis of findings of earlier studies (Cole et al., 1971; Fobih, 1979; Luria, 1976; Scribner, 1977; Sharp et al., 1979), it is hypothesized that the main effects of schooling and age as well as their interaction would be significant with respect to performance on the Syllogistic Reasoning Test.

Hypothesis 7

Basic to solving concrete operational tasks is the child's ability to integrate information from several sources in order to arrive at a correct judgment, and the manner of this integration is compatible with the characteristics of simultaneous processing (Cummins & Das, 1978; Mwamwenda, 1981). It is therefore, hypothesized that simultaneous and not successive processing would be involved in solving Piagetian tasks.

It is rather difficult to advance any specific hypotheses concerning the relationship of simultaneous and successive processes with performance on Clustering in Free Recall, Serial Short-Term Recall, and Syllogistic Reasoning Tests. The relationship of coding processes with these test skills would be examined on an exploratory basis.

Sample

The sample consisted of 250 subjects, with 50 children selected from each of the following subject populations: (1) 4-6 year old preschool children, (2) 6-8 year old

nonschooled children, (3) 6-8 year old schooled children in Grade two, (4) 10-12 year old nonschooled children, (5) 10-12 year old schooled children in Grade five. The mean ages of the five subgroups were 5.25, 7.5, 7.4, 10.75, and 10.8 years respectively.

All testing was carried out in Orissa, a South-Eastern state of India. The testing project was conducted in 14 villages in the locality of Angul, which is a small town approximately 100 miles north of the state capital, Bhubaneswar. These 14 villages are spread around Angul within a distance ranging from 2 to 15 miles. The demographic characteristics of these villages are highly homogeneous. At least 75% of the villagers belong to lower socio-economic status. They earn their livelihood from agriculture or from unskilled labor on a daily wage basis, which would not be more than 50 cents Canadian per day for an adult. The population of the villages varies from 1000 to 2500, with an adult literacy rate of less than 25%. The villages are underdeveloped; there is no running water, electricity, telephone or bus service. The roads are unpaved and there are no modern facilities for agriculture.

The schooled and nonschooled samples came from the same villages, and in some cases, from the same families. In order to keep the major sociodemographic characteristics of the schooled and the nonschooled children relatively homogeneous, the sample included only boys selected from *middle-caste* homes of these 14 villages. The high-caste

homes, in this culture, inherit a relatively rich cultural and scholastic tradition. High-caste status, on the average, is associated with relatively higher parental income, education, and occupation - variables which correlate highly with the child's school achievement. Thus, it is not surprising that more children from these homes attend school and show higher levels of academic competence. On the other hand, the demographic characteristics of low-caste homes are markedly different. These homes, in general, are characterized by poverty, occupations of a menial nature, illiteracy, and a complete lack of parental interest in the child's education. Needless to say, very few children from these homes attend school. Similarly, sex poses another potential source of selection bias; that is, more boys compared to girls attend school, especially in the middle-caste homes. Traditionally, in this culture, girls are trained to do the household work, and assist their mothers in child-care. This restriction however, does not apply to boys in this male-dominant culture. Hence, in this culture, comparison of schooled and nonschooled groups, disregarding the caste and sex boundaries would only accentuate the problem of selection bias. Consequently, the influence of schooling on cognitive functioning would be overestimated. Therefore, girls and children from either higher- or lower-caste homes were deliberately excluded from the sample.

One cannot explicitly deny the possibility of a nonrandom selection of boys who attend or do not attend school. However, upon asking the parents, the children, and interacting with village people, it was not possible to find any systematic cognitive factors determining the suitability of schooling for some boys and not for others. Many nonschooled children at a very young age accompanied their older siblings to schools, thereby allowing their parents to work on the farm land without interference. However, these children did not participate in the reading and writing experiences provided by the school. Furthermore, when they attained school-age, they often refrained from going to school as they had already discovered that teachers were authoritative and punishing, and the school environment was threatening. In some cases, children did not go to school because their service was required in domestic work. In a particular village, many children were not sent to school as the school is separated from the village by a river, which claims two or three lives every year during the rainy season. On the basis of these observations, we can assume that school attendance was influenced by idiosyncratic individual characteristics rather than by any significant difference in the general intellectual level between those children who attended schools and those who did not. If the child did not go to school, he was asked to assist his parents in household work or on the farm.

The 14 schools sampled in this study showed very little physical variability. Typically, the school consists of three to four rooms, and five grades (Grades 1 to 5), with more than one grade in a room. The language of instruction is Oriya, which is the native language of the state. The curriculum of these schools is exactly the same as in any other school throughout the state. Because of the poor training of teachers and the lack of availability of any instructional aids, the quality of teaching-learning conditions in these schools is very poor. Rote learning as the technique of teaching and mastering the contents of the curriculum is the rule, and it is followed tenaciously by both teachers and pupils.

Descriptive Sample Characteristics

Information on major sociodemographic characteristics of the schooled and nonschooled sample was obtained through a structured questionnaire. Table 1 presents the means and standard deviations of the five groups on nine sociodemographic variables.

Father's occupations were rated on a five-point scale as follows: (1) daily laborer, (2) self-employed farmer, (3) nonfarm laborer, (4) government worker, and (5) professionals (school teachers). Father's annual income was divided by the number of siblings to obtain an index of income per child per annum. The income per child per annum was rated on a five-point scale as follows: (1) below 250 Rupees, (2) 251-500 Rupees, (3) 501-750 Rupees, (4) 751-1000

Table 1

Descriptive Sample Characteristics
(N = 50 in each group)

Variables		4-6 Nsch	6-8 Nsch	6-8 Sch	10-12 Nsch	10-12 Sch
Father's Education	Mean	3.72	1.88	4.40	1.72	3.36
	SD	2.90	2.17	3.61	1.90	3.09
Father's Occupation	Mean	2.86	2.12	2.84	1.76	2.64
	SD	1.18	1.02	1.33	.77	1.10
Family Income (per capita)	Mean	2.86	2.08	2.74	1.94	2.72
	SD	1.11	.78	1.21	.47	1.09
Income per Child	Mean	3.30	2.58	3.46	2.18	3.02
	SD	1.17	1.01	1.18	.69	1.13
Landed Property (in Acres)	Mean	2.22	1.23	2.23	.95	3.02
	SD	1.79	1.37	2.72	1.09	3.44
Family Size	Mean	6.64	6.90	7.04	6.94	7.52
	SD	2.78	1.85	3.20	2.24	2.85
Number of Siblings	Mean	4.06	4.54	4.38	4.46	4.62
	SD	1.70	1.37	1.86	1.56	1.54
No. of Literate Family Members	Mean	2.18	1.10	2.64	1.06	2.90
	SD	1.76	1.37	1.63	1.17	1.57
No. of Literate Siblings	Mean	1.22	.64	1.54	.68	1.74
	SD	1.50	1.01	1.43	.87	1.26

Rupees, and (5) above 1000 Rupees (One Canadian Dollar is approximately equivalent to seven Indian Rupees). Many of the families were joint families, and there was more than one wage-earning member in some families. The total income of the family was shared by all members of the family. Hence, an index of per capita income of the family members was obtained by dividing the annual family income by the family size. The per capita income so obtained was also rated on a five-point scale similar to the one used for rating the per capita income for siblings.

The three important sociodemographic variables were father's education and occupation, and per capita income of the family. All other demographic variables except family size and number of siblings were highly correlated with these three variables (Table 2). A multivariate analysis of variance performed on these three variables revealed a significant difference between schooled and nonschooled children (Table 3). The 95% simultaneous confidence intervals yielded by the MANOVA indicated a significant difference in father's educational level between the younger schooled and nonschooled groups, but not between older schooled and nonschooled groups. For father's occupation, and per capita family income, significant differences were obtained between older schooled and nonschooled, but not between younger schooled and nonschooled children.

The statistical analysis on the three major sociodemgraphic variables mentioned above yielded

Table 2

Intercorrelations among Major Survey Variables
(N = 250)

Variables	1	2	3	4	5	6	7	8	9
1. Father's Education									
2. Father's Occupation	.53								
3. Percapita Family Income	.47	.61							
4. Income per Child	.49	.60	.81						
5. Landed Property	.16	.19	.50	.45					
6. Family Size	-.03	.00	-.10	-.16	.35				
7. Number of Siblings	-.07	-.06	-.17	-.32	.18	.76			
8. No. of Lit. Fam. Members	.46	.36	.37	.30	.46	.53	.41		
9. No. of Lit. Siblings	.25	.26	.23	.16	.30	.45	.48	.88	

Table 3

Summary of MANOVA for Father's Education, Father's Occupation and Family Income

Source	df	F	p
Schooling (A)	3	14.002	< .001
Age (B)	3	1.40	> .05
A X B	3	.94	> .05
Error	191		

significant differences between schooled and nonschooled groups; whether or not these differences were of any practical significance needs to be evaluated by cross-cultural psychologists. Mostly the parents of schooled and nonschooled children belonged to the lower socio-economic stratum of the society. In a 'society' where most of the time and energy is spent in meeting the basic necessities of life, parents can afford very little time to provide intellectual support to the children. In the context of this, a two grade-point difference in the mean parental educational level of schooled (Mean = 3.88), and nonschooled (Mean = 1.80) groups was of least practical significance for the children's intellectual pursuit. With respect to father's occupation, the means indicated that fathers of nonschooled children were mostly self-employed farmers, while those of schooled children were mostly self-employed nonfarm laborers. Judged in terms of the importance of father's occupational level for the child's academic pursuits, the difference between a self-employed farmer and a self-employed nonfarm laborer was not a remarkable shift in the parental occupational level. Similarly, the mean per capita family income (per annum) was slightly above 500 Rupees for the nonschooled sample, and was close to 700 Rupees for the schooled sample. This difference of 200 Rupees ($27 Canadian) in per capita family income per annum may not be considered very remarkable. On the basis of this evidence, it may be argued that schooled and nonschooled

groups came from relatively homogeneous sociodemographic background.

Tests

All subjects were administered the simultaneous, successive, and planning battery. In addition, 25 out of 50 children from each of the five groups took four Piagetian tests: Conservation of Length, Conservation of Mass, Transitivity, and Class Inclusion. The Clustering in Free Recall and the Serial Short-Term Recall Tests were given to the remaining 25 subjects in each group. Moreover, 30 subjects in each group took the Syllogistic Reasoning Test. Only the schooled children were given an adapted version of the Schonell Word Reading Test. The tests, their administration and scoring procedures are described below.

Word Reading Test

The original version of the test (Schonell, 1968) consists of 100 English words in order of increasing difficulty. In the present study, an adapted version of this test in Oriya (an Indian language) was used to examine if the schooled subjects were reading words at their respective grade levels. The printed sheet of 100 Oriya words was placed squarely in front of the child with the instruction to read the words at his own pace. The child's score was the number of words correctly read.

Figure Copying

This test has been identified as a marker test for 'simultaneous' processing (Das, Kirby, & Jarman, 1975). It was originally used as a test of developmental readiness at the Gesell Institute (Ilg & Ames, 1964). In this test, the subject was required to reproduce 10 geometric patterns of increasing difficulty, which were then scored 0, 1, or 2 according to the accuracy of reproduction. The maximum possible correct score was 20. Scoring criteria emphasized the maintenance of geometric relations and proportions rather than exact reproduction.

As the nonschooled subjects used in this study were not familiar with paper and pencil tasks, they were required to draw the patterns on a slate with a piece of chalk or to draw the designs on sand with the help of their finger. It took approximately 7-10 minutes to administer the test.

Memory for Designs

This test originally derived from Graham and Kendall (1960) has been identified as a stable marker test for 'simultaneous processing'. The test material consisted of 15 simple straight line designs. Each was shown to the child for a 5 seconds viewing period. Subjects were required to reproduce each design from memory. Their responses were then scored 0, 1, 2, or 3 depending on the correctness of reproduction. The

subject's scores were added over 15 designs for a maximum possible score of 43.

Again, since nonschooled children were not familiar with paper and pencil tasks, they were required to reproduce the designs in the same way as they did in the Figure Copying Test. It took approximately 5-8 minutes to administer the test.

Auditory Serial Recall

This is a marker test of successive processing. The version used in this study consisted of 12 lists of words which began with a four-word series and progressed to a six-word series. There were four lists for each of the four-, five-, and six-word series. The subjects were required to recall each series in correct serial order. The number of words recalled in correct serial position constituted the serial recall score of the subject. The maximum possible score on this test was 60, and the administration time for the test was approximately 4-6 minutes.

Digit Span

This successive marker test is abstracted directly from the Wechsler Intelligence Scale for Children (WISC). A series of digits of increasing length were read out to the subjects who were required to recall the digits in correct serial order. The subject's score was the number of digits in the series of maximum length recalled correctly. It took approximately 2 minutes to

administer the test.

Visual Search

This is a marker test of planning (Ashman, 1978). In the original version of the test, the subject looks at an encircled target pattern in the center of a transparency, and then searches for a duplicate of this pattern in a field where the standard shape appears along with a number of distracting patterns. The time taken to find the standard shape is the visual search time which is a measure of planning. The transparencies are shown in a viewing apparatus made specifically for this purpose.

Since the apparatus was not available for use with children in India, a slightly different version of this task was used in the present study. Xerox copies of the four transparencies were used and the time taken to identify the duplicate of the target was recorded by a stop watch. The time for administering this test was approximately 2-3 minutes.

Trail Making

This test was reported by Armitage (1946) to measure planning and was subsequently identified as a marker test for 'planning' (Ashman, 1978). Two forms of this test exist: an intermediate form (ages 5-14) and an adult level. Each form is also divided into parts A & B. The intermediate form was used in the present study.

In part A, the subject was instructed to connect encircled numbers distributed randomly over the page in correct numerical order. In part B, which consisted of letters and numbers, the subject was required to draw lines alternately between numbers and letters in correct increasing sequence (for example, 1-A-2-B-3-C...). Total elapsed time to complete each part of the test was recorded separately. It took approximately 5 minutes to administer the test. Since this test involved the recognition of numbers and letters, it was given only to the school children.

Both schooled and nonschooled subjects were administered a different version of the test using playing cards. The playing cards varied in number (1-10), and color (black & red). Instead of numbers and letters, these two dimensions were utilized effectively without altering the principles involved in the task. The first form of the task used cards in increasing numerical sequence from only one suit. The subject was asked to move his finger across randomly distributed cards in a correct numerical order. The second form used both red and black colored cards. In the second form, the subject was asked to move his finger alternately between number and color in correct increasing sequence.

Color Naming

This task tends to load on a 'speed' factor. Subjects were presented with a chart, approximately

100cm.X 50cm., upon which strips of four basic colors were randomly arranged in eight rows with five strips per row. The subjects were asked to name the colors from left to right and through rows one to eight. The score was the subject's time to complete the task, recorded in seconds. It took approximatley 2-5 minutes to administer the test.

The following Piagetian concrete operational tasks were given only to 25 subjects in each of the five groups.

Conservation of Length

Two straight eight-inch-long rods were used. The child was presented with these two rods. They were lying parallel and their ends were in alignment. The child was asked: "Are the rods the same length? Is this rod (top rod) as long as this one (bottom rod)?" After the child gave the response 'yes', the bottom rod was moved so that their ends were no longer in alignment. The child was asked the same question as above. If the child agreed to equality, the experimenter asked for the justification of the response: "How do you know?" Where the subjects could not verbally explain their judgment, they were asked a few additional questions, "Is this (bottom rod) longer or that (top rod) longer? Are they of equal length or not? Is any of the rods longer than the other? Then the bottom rod was moved again so that both the rods formed a 'T' shape. The same questions

were repeated again. If the subject agreed to the equality, he was again asked for the justification: "How do you know?" The response was scored 0 if the equality was not understood while the rods were parallel without their ends being in alignment. He got a score of 1 if he agreed to equality when the rods were parallel, and a score of 2 if the equality was understood in all situations including the one when the rods were in the 'T' shape.

In the second form of the task two ropes of the same length were used. The procedure of administration was the same as before. The subject was asked to compare the lengths of the ropes in two situations: when the ropes were lying parallel in straight lines without their ends being in alignment; and when one rope was straight and the other coiled. The subject got a score of 1 if he agreed to equality in the first situation, and a score of 2 if he understood equality in all situations. The time for administering this test was approximately 5 minutes. The scores from the two forms of the test were added to produce a total score for each subject.

Conservation of Mass

Each subject was given two equal and two unequal balls made of dough. Then the subject was asked to choose from the four balls any two that were the same. If the subject did not find any two balls equal, he was

asked to make them equal by taking some pieces from the larger ball and adding them to the smaller one. After he agreed to the equality of the two balls, the experimenter proceeded as follows:

1. Suppose I make this ball here into a cake, will there be the same amount to eat in the cake as in that ball or not?
2. Now I am making this ball into a cake (while the subject looks on). Is there the same amount to eat in the cake as in the ball?
3. Why do you think so?

The correct answer to each of the first two questions was given a score of 1. The maximum possible score for the test was 2. It took approximately 4 minutes to administer the test.

Transitive Inference

This task was given in two modes: visual mode and verbal mode. In the visual mode, seven sticks of different colors and length were used. The seven sticks were: A (white), B (red), C (black), D (yellow), E (orange), F (gray), and G (pink). The length of these seven sticks had the following relationships: A=B=C, E<B<D, and F<B<G. Each subject was given five trials. In each trial, three sticks were used. Based on the relationships between the 1st and the 2nd sticks, and 2nd and 3rd sticks, the subject was asked to judge the relationship between the 1st and the 3rd sticks. The

relationship of the three sticks in five trials were as follows: A=B=C, A=B<D; F<B=C; A=B>E; and G>B=C. The subject's responses were scored from 0 to 5 corresponding to the number of trials in which he gave the correct answer. The subject was also asked to give justification for his answers.

In the second part, the subject was required to make transitive inferences as the premises were presented to him verbally. There were four 3-term questions. Given the relationship between persons 1 and 2 (Mary is taller than Sue), and persons 2 and 3 (Sue is taller than Cathy), the subject was asked to judge the relationship between persons 1 and 3 by responding to a question of the form, "Who is taller? Mary or Cathy?" The subjects' responses were scored for the number of items correctly answered. The maximum score for the test was 4. For both the forms of this test, the administration time was approximately 8-10 minutes.

Class Inclusion

This test was given in both pictorial and verbal forms. In the pictorial form, four cards were used. The first card contained the line drawings of eight animals: five cows and three dogs. As the child examined the pictures, he was asked to name the pictures and the superordinate class of those pictures. Then four questions were asked - "Are there more cows or more dogs? Are there more cows or more animals? If all the

cows would be removed, what would be left? If all the animals would be removed what would be left?" The correct answer to each question was given a score of 1. Similarly, the child was presented with three additional sets of pictures whose superordinate classes were as follows: 'children', 'flowers', and 'clothes'. In each set the child was asked four questions similar in form to the first set. In this study, the scores obtained in the second question for each set were added to produce a total class inclusion score for the pictorial form; the maximum possible score was 4.

In the second part of the test, the child was asked some questions about the class inclusion phenomenon without the help of pictorial materials. There were four sets of questions. For the first set, the questions were as follows: In your village, are there more cows or more animals? If all the cows die, would there be any animals left? If all the animals die, would there be any cows left? A Similar pattern of questioning was followed for the additional three sets, which dealt with the superordinate classes 'trees', 'fish', and 'fruits'. The correct answer to each question was given a score of 1. The score on the first question was added over the four sets to produce a maximum possible score of 4 for this test. For both forms of this test, the administration time was approximately 10-15 minutes.

Two (Category Clustering in Free Recall and Serial Short-Term Recall of Locations) of the following three tests were given to 25 subjects in each group. The Syllogistic Reasoning Test was given to 30 subjects in each group.

Category Clustering in Free Recall

This test was similar to the ones used to study organizational features of free recall (Bousfield, 1953; Cole et al., 1971). The test materials consisted of 16 familiar line drawings, four from each of the categories of animals, fruits, vehicles and limbs. Each drawing appeared on a white card (3X4 inches). The subject was shown all the drawings one after another in a random sequence with each drawing being presented for a two seconds viewing period. As each drawing was presented, the subject was asked to tell the names of the drawings aloud. Following the completion of the first trial, the subject was asked to recall from memory what he saw. After the subject indicated that he could not recall any more, the next trial began. Each subject was presented the drawings three times but in a different order each time.

The subjects' responses were scored for the amount of clustering exhibited in the recall output using Bousfield's (1953) 'ratio of repetition index' (RR).

Following the completion of three trials, two additional trials were given with verbal cues both at

the time of presentation and recall to see if any improvement in recall would occur. The instructions given below on the fourth- and fifth trials demonstrate how verbal cuing was done.

Fourth Trial (Cued at both presentation and recall): "I will show you the same pictures again. There are some pictures of animals, some pictures of fruits, some of limbs, and some of vehicles. Look at them carefully (The items were then shown one at a time, each for 2 seconds). You tell me the names of the pictures. They are animals, fruits, limbs, and vehicles. Now tell me what you saw."

Fifth Trial (Constrained recall): For this trial, the instruction was the same as for the previous one up to the point where recall began. Then the subject was asked, "Tell me the names of all animals you saw. Tell me the names of all fruits you saw, " and so on.

The responses on the third and the fourth trial were scored for the amount of clustering exhibited. The number of words recalled on the fifth trial was recorded. It took approximately 10 minutes to administer the test.

Serial Short-Term Recall of Locations

This test was similar to the one used by Wagner on Mexican subjects (Wagner, 1974), and Moroccan subjects (Wagner, 1978) to study the influence of age, schooling, and environment on structural features and control

processes in memory. The test materials consisted of sets of seven white cards (3 X 4 inches), with a line drawing of a familiar animal appearing on one side of each card. A given set contained seven cards and a 'probe' card containing a line drawing of one of the animals. The task for the subject was to remember the locations of seven animal drawings as each card was presented for a 2 secs. viewing period, and then placed face down in front of the subject from left to right in a linear arrangement. After two seconds, the subject was shown the probe card with the instruction to point to the card in the row that contained the same animal. Each subject was given 14 test trials such that each serial position was probed twice, and a particular serial position was never probed in two consecutive trials. Since in a trial, the cards were laid down from left to right, the serial position of the probe was related to the time interval between presentation of a given card and the probe-recall. The subjects' responses were analyzed for overall, primacy, middle-positions, and recency recall.

It took approximately 12-15 minutes to administer the test individually. This task was pictorial in nature, requiring little verbal response, and was therefore, easy to administer to the nonschooled children.

Syllogistic Reasoning

The test consisted of 14 items, which were very similar to those used by previous investigators (Bickersteth, 1979; Fobih, 1979; Luria, 1971; Sharp et al., 1979). The 14 items are given in Appendix I. There were two syllogisms from each of the following seven categories. (1) familiar, (2) unfamiliar, (3) contrary to experience, (4) artificial, (5) conjunctive, (6) disjunctive, and (7) implicative. All subjects were tested individually in an informal interview type situation. They were also asked to give justifications for their answers. A correct answer to each question was given a score of 1. The total score for each subject was obtained by adding his score over all the items in the test. It took approximately 12-15 minutes to administer the test.

Procedure

The tests were administered by the author with the help of two research assistants who had Master's degrees in Psychology from a University in Orissa, India. The research personnel were all natives of Orissa, and spoke the same langauge as that of the subjects. Being born and brought up in the rural traditions of the state, the investigators shared a part of the subjects' culture, and its customs, rituals, and conventions. Thus, there were no linguistic or cultural barriers between the investigators and subjects.

All the research personnel lived in the locality of Angul for the 8-month period of data collection. The permission of the District Inspector of Schools was first obtained to carry out this research in 14 primary schools in the locality of Angul. The school children were tested in a separate room or in a quiet hallway provided by the Head Masters of respective schools. Most of the teachers in the schools were cooperative with the investigators during the project work. The nonschooled children were drawn from the same villages that the schooled children came from. Although, at the beginning, some of the villagers were suspicious of the investigators' intentions, the investigators were able to establish rapport with the leader-like adult members of the community, and sought their cooperation in obtaining the nonschooled sample. As a partial payment for the help received, some financial reinforcements were provided to these contact persons as well as to the nonschooled children. The nonschooled subjects were tested in their respective villages either in a room provided by the contact persons or in an open field near the village. Since, the 4-6 year old nonschooled children did not feel comfortable being alone with the experimenter, their elder brothers or sisters or any adult member of the community were allowed to sit beside them during the period of testing.

All children were tested individually in their native language, Oriya, which is the medium of instruction in the

primary schools of the state. All the tests were administered in the order they have been described in this section. After establishing some level of rapport with the child, the testing session began. Each test was accompanied by a few practice trials at the beginning in order to make the instructions clear for the subject. The subjects were administered all the tests either in two or three sessions separated by 10-15 minutes interval.

Results and Discussion

This part is organized by the type of skills investigated. The first two sections deal with the Piagetian concrete operational tasks, and the simultaneous-successive-planning battery respectively. In both sections, the results of MANOVA, ANOVA, as well as the correlational data are presented. The evidence for the factorial validity of the simultaneous, and successive coding processes is also presented. The next three sections describe the results of the cognitive tests (Clustering in Free Recall, Serial Short-Term Recall of Locations, and Syllogistic Reasoning) which measure cognitive skills thought to be promoted by schooling experience. In the sixth section, the relationships of simultaneous and successive processes with the concrete operational skills are examined. The seventh and final section examines the relationships of simultaneous and successive processing with the three specific cognitive skills.

Piagetian Concrete Operational Skills

The means and the standard deviations of the six Piagetian concrete operational tasks are presented in Table 4, and their intercorrelations in Tables 5, and 6.

Correlational data: The intercorrelations presented in Table 5 were derived from the pooled variance-covariance matrices of the three young age groups: 4-6 year old nonschooled, 6-8 year old schooled, and 6-8 year old nonschooled groups. This was done by averaging the variance-covariance matrices of the three groups, and by pre- and post-multiplying this matrix with the inverse of the diagonal matrix of the standard deviations of all the six variables. The purpose underlying the computation of the correlations in this manner was to prevent the age variable from overinfluencing the correlations, and also to increase the sample size on which the correlational data are based. The same procedure was also adopted in deriving the correlations presented in Table 6.

As may be seen in Table 5 and 6, the intercorrelations between the two conservation tasks as well as those between the pictorial and verbal forms of Class Inclusion were significant. The two forms of Transitivity showed very low negative correlations. The concrete form of Transitivity did not correlate significantly with either the Conservation or Class Inclusion tasks. It may be noted here that the pattern of the correlations remained the same when the nonpooled correlations were obtained by combining the data of these

Table 4

Means and Standard Deviations of Six Piagetian Tests*
(N = 25 in each group)

Tests		4-6 Nsch	6-8 Nsch	6-8 Sch	10-12 Nsch	10-12 Sch
Conservation of Length (4)	Mean	1.72	2.84	3.20	3.84	3.92
	SD	1.26	1.65	1.53	.62	.40
Conservation of Mass (2)	Mean	1.16	1.28	1.52	1.76	2.00
	SD	.94	.89	.82	.52	.00
Transitivity (Concrete) (5)	Mean	3.32	3.84	4.08	4.44	4.56
	SD	1.38	.94	.91	.71	.91
Transitivity (Verbal) (4)	Mean	1.24	1.76	2.00	1.88	2.52
	SD	.99	1.11	.80	.91	1.02
Class Inclusion (Pictorial) (4)	Mean	1.48	1.48	1.56	2.80	2.92
	SD	1.00	1.33	1.26	1.41	1.44
Class Inclusion (Verbal) (4)	Mean	2.20	2.60	2.88	3.36	3.80
	SD	1.32	1.22	1.00	.95	.50

* Number in parentheses against each test is the maximum possible score for that test

Table 5

Intercorrelations (pooled) among Piagetian Tests
for the Three Younger Age Groups
(4-6 Nsch, 6-8 Nsch, 6-8 Sch: N = 75)

Variables	CL	CM	TRC	TRV	CIP	CIV
Conservation of Length (CL)						
Conservation of Mass (CM)	.508					
Transitivity (Concrete) (TRC)	.105	.139				
Transitivity (Verbal) (TRV)	-.038	.043	-.113			
Class Inclusion (Pict.) (CIP)	-.047	.032	.146	.124		
Class Inclusion (Verbal) (CIV)	.024	.073	.021	.110	.435	

Table 6

Intercorrelations (pooled) among Piagetian Tests
for the Three Nonschooled Groups
(4-6 Nsch, 6-8 Nsch, 10-12Nsch: N=75)

Variables	CL	CM	TRC	TRV	CIP	CIV
Conservation of Length (CL)						
Conservation of Mass (CM)	.480					
Transitivity (Concrete) (TRC)	.090	.107				
Transitivity (Verbal) (TRV)	-.067	.034	-.200			
Class Inclusion (Pict.) (CIP)	.004	.130	.098	.278		
Class Inclusion (Verbal) (CIV)	.037	.148	-.002	.118	.611	

five groups in several possible ways. The correlational data suggest that the concrete operational skill as measured by these four tests is multidimensional in nature.

Factor analysis: The correlational data presented in Tables 5 and 6 were analyzed using principal components analyses and three factors having eigen values greater than 1 were rotated to the varimax criterion. The implications of the correlational data are further supported by the principal components analysis of the six variables (Table 7). The three factors in both the analyses were defined by Conservation, Class Inclusion, and Transitivity tasks respectively, suggesting that these three sets of tasks were not unidimensional in defining the concrete operational skill. When two factors were rotated, instead of three, the communalities of the two Transitivity tasks were greatly reduced, and the two factors were defined by the Conservation and Class Inclusion tasks respectively.

The pattern of loadings on the three factors remained remarkably consistent when the nonpooled correlations of the three young and also the three nonschooled groups were analyzed separately using the principal components analysis. When the principal components analysis was employed on the entire sample, or with the preschool group excluded, the results were essentially the same.

The consistency in the pattern of results suggests that the skill assessed by these tests is not characteristically unidimensional. Thus, success in any one of the tasks may

Table 7

Principal Components Analysis with Varimax Rotation of Six Piagetian Tests

Tests	Younger Age Groups (N = 75)				Nonschooled Groups (N = 75)			
	I	II	III	h2	I	II	III	h2
Conservation of Length	.859	-.062	.058	.745	-.056	.866	.065	.757
Conservation of Mass	.866	.071	.011	.755	.147	.850	.010	.744
Transitivity (Concrete)	.172	.248	.745	.646	.188	.078	.822	.717
Transitivity (Verbal)	.090	.275	-.740	.631	.320	.006	-.717	.616
Class Inclusion (Pictorial)	-.049	.850	.072	.730	.904	.027	-.047	.820
Class Inclusion (Verbal)	.051	.797	-.092	.647	.849	.064	-.019	.726
% of Total Var.	25.516	25.070	18.651		28.357	24.725	19.944	

not be taken as evidence for the attainment of the concrete operational stage. Instead, a variety of concrete operational tasks should be used to assess the mastery of concrete operations.

Essential to Piaget's theory is the fact that each cognitive stage reflects a fundamental underlying structure. But, within each stage, there exist qualitatively distinct developmental substages, characterized by their own logical structures. Within the concrete operational stage the age of onset of various logical concepts such as conservation, transitivity, and class inclusion are different, because the processes underlying these concepts appear at different points in the developmental continuum. These concepts develop sequentially rather than in a parallel fashion. Since different processes are involved in the acquisition of concrete operational concepts, it is reasonable to expect that these tests can be factor analyzed into more than a single significant factor. In this respect, the findings of the present study were consistent with those of Carlson and Weidl (1977), who showed that Piagetian concrete operational tests are multifactorial in nature.

Group differences: The factor pattern of the six Piagetian tests provided a rationale for examining the group differences on clusters of tests simultaneously, rather than on each test separately. Accordingly, the MANOVA was employed to analyze the data for the two Conservation tasks, and also for the two forms of Class Inclusion. Since, the

two forms of Transitivity loaded in opposite directions on a single factor, they were analyzed separately using ANOVA's.

Essentially the five groups constituted an unbalanced two dimensional design consisting of three age groups (4-6; 6-8; 10-12) and two kinds of schooling experience (schooling vs. nonschooling). Since the 4-6 age group is a preschool group, they could not be split on the basis of schooling experience. Hence the design was unbalanced.

Since the analytical procedure adopted in examining group differences is not frequently encountered, it will be described briefly using as an example, the two Conservation tasks. A one-way MANOVA was performed on all the five groups. The pooled error variance estimate obtained from this analysis was used in the denominator to obtain 'F' statistics for all the contrasts mentioned below. (This was done to guard against uncontrolled Type I error which could have been encountered by doing three separate analyses based on three different error terms i.e., by excluding the 4-6 year old group, and comparing the remaining four groups in a 2 (schooling) X 2 (age) factorial design, and by comparing the preschool group separately with younger schooled and nonschooled groups.)

Following the main analysis, the combined mean of the two schooled groups was compared with that of the two nonschooled groups to obtain the main effects of schooling. Similarly, the two younger age (6-8) groups were contrasted with the two older age (10-12) groups to obtain the main

effects of age. For obtaining the school X age interaction, the combined mean of the younger nonschooled and older schooled groups was compared with that of younger schooled and older nonschooled groups. By further post-hoc contrasts, the simple effects of schooling at each age level, and the simple effects of age separately for the schooled and the nonschooled samples were calculated. Moreover, the 4-6 year old preschool group was compared with each of the younger schooled and nonschooled groups. The analytical procedure was essentially the same when ANOVA's were employed to analyze the data for the Transitivity tasks. The 'F' values yielded by these comparisons are presented in Table 8.

As may be seen in Table 8, the main effects of age were significant for all the Piagetian tasks; neither the main effect of schooling nor its interaction with age was significant for any of the Piagetian tests. The simple effect of schooling was significant at the older age level only for the verbal form of Transitivity, thus implying the superiority of schooled children for tasks, where the mode of presentation is verbal. However, the absence of a significant difference between the younger schooled and nonschooled groups suggests that one year of schooling does not significantly improve the ability to deal with tasks requiring verbal modes of representation. Since the verbal form of Class Inclusion does not demand the same processing requirements as that of the verbal form of Transitivity, no significant difference was noted between schooled and

Table 8

A Summary of 'F' Statistics Showing the Effects of Age (A) and Schooling (B) on Piagetian Tasks

Source	df	Conser-vation	df	Class Incl.	df	Trans. (Conr)	df	Trans. (Verbal)
Age (A)	2	7.32**	2	15.45**	1	7.36**	1	4.94*
Schooling (B)	2	1.36	2	1.54	1	<1	1	2.61
A X B	2	<1	2	<1	1	<1	1	1.02
(6-8)Nsch vs (10-12)Nsch	2	4.38*	2	7.16**	1	4.54*	1	<1
(6-8)Sch vs (10-12)sch	2	3.14*	2	8.36**	1	2.91	1	3.44
(6-8)Nsch vs (6-8)Sch	2	<1	2	<1	1	<1	1	<1
(10-12)Nsch vs (10-12)Sch	2	<1	2	1.15	1	<1	1	5.21*
(4-6)Nsch vs (6-8)Nsch	2	5.43*	2	1.10	1	3.41	1	3.44
(4-6)Nsch vs (6-8)Sch	2	8.40**	2	2.94	1	7.28**	1	7.34**
Error	119		119		120		120	

* $p < .05$
** $p < .01$

nonschooled groups in Class inclusion. The simple effects of age were significant for the Conservation, and the Class Inclusion tasks for both the schooled and nonschooled groups. However, compared to 4-6 year old preschooled children, both the 6-8 year old schooled and nonschooled groups performed at a significantly higher level in the two conservation tasks, but not in Class Inclusion. In this respect, the data support the idea that conservation concepts are attained prior to class inclusion. The results suggest that the schooled and nonschooled groups were operating at the same developmental level as indexed by their performance on Piagetian concrete operational tasks.

Some alternative ways of analyzing the data were also attempted. Since all the Piagetian tasks are measures of concrete operational skill, a MANOVA was employed to examine group differences on all six tests considered simultaneously. The pattern of results was essentially the same as that reported in Table 8.

Since the verbal mode of presentation is not dictated by Piagetian theory, the data for the four tests (excluding the two verbal forms) were also analyzed using a MANOVA. The results of this analysis were, once again, essentially similar to the ones reported above. The results of these MANOVA's are given in Appendix II.

Stage analysis: The most prevalent method of investigation in Piagetian research is to use a Chi-square analysis on the frequencies of subjects who attain different levels of

concrete operational skills in different samples. In order to supplement the results obtained from the use of parametric statistics, and also to compare the results of the present study with those of other investigators, the Chi-square technique was also used. The frequencies of subjects in the Acquisition (A), Transition (T), and No-Acquisition (NA) stages for each of the five groups under investigation are presented in Table 9. Those subjects who scored less than 50% of the maximum possible score for a test were in the No-Acquisition stage, whereas those whose scores ranged from 50% to 75% were judged to be in the Transition stage; all others were in the Acquisition stage. The Chi-square statistics comparing the schooled and nonschooled groups are given in Table 9. None of the Chi-square values was significant, thus supporting the earlier finding that the schooled and nonschooled groups were performing at an equal level of competence on the Piagetian tasks.

The present study supports the findings of earlier researchers (Fahrmeier, 1978; Goodnow & Bethon, 1966; Kiminyo, 1977; Mermelstein & Shulman, 1967; Nyiti, 1976), who reported no direct relationship between schooling and the development of concrete operations. However, the findings from Piagetian research have not been consistent. Several other studies (Greenfield, 1966; Laurendeau-Bendavid, 1977; Okonji, 1971; Owoc, 1973; Philp & Kelly, 1974) found that schooled children acquired concrete

Table 9

Chi-Square values Between Schooled and Nonschooled Groups on the Frequencies of Subjects in No-Acquisition (NA) Transition (T) and Acquisition (A) Stages in Piagetian Tasks

Tests	4-6 Nsch			6-8 Years						10-12 Years					
				Nsch			Sch			Nsch			Sch		
	NA	T	A	NA	T	A	NA	T	A	NA	T	A	NA	T	A
Conservation of Length	11	7	7	7	2	16	4	2	19	1	1	23	0	1	24
ChiSquare				1.07						1.02					
Conservation of Mass	9	3	13	7	4	14	4	3	18	1	4	20	0	0	25
Chi-Square				1.46						5.55					
Transitivity (Concrete)	4	7	14	0	9	16	0	9	16	0	3	22	0	2	23
Chi-Square				0.00						.22					
Transitivity (Verbal)	15	7	3	8	11	6	5	15	5	9	9	7	3	9	13
Chi-Square				1.40						4.80					
Class Inclusion (Pictorial)	12	9	4	14	6	5	13	6	6	5	3	17	4	3	18
Chi-Square				.13						.14					
Class Inclusion (Verbal)	6	6	13	6	4	15	3	5	17	2	2	21	0	2	23
Chi-Square				1.23						2.09					

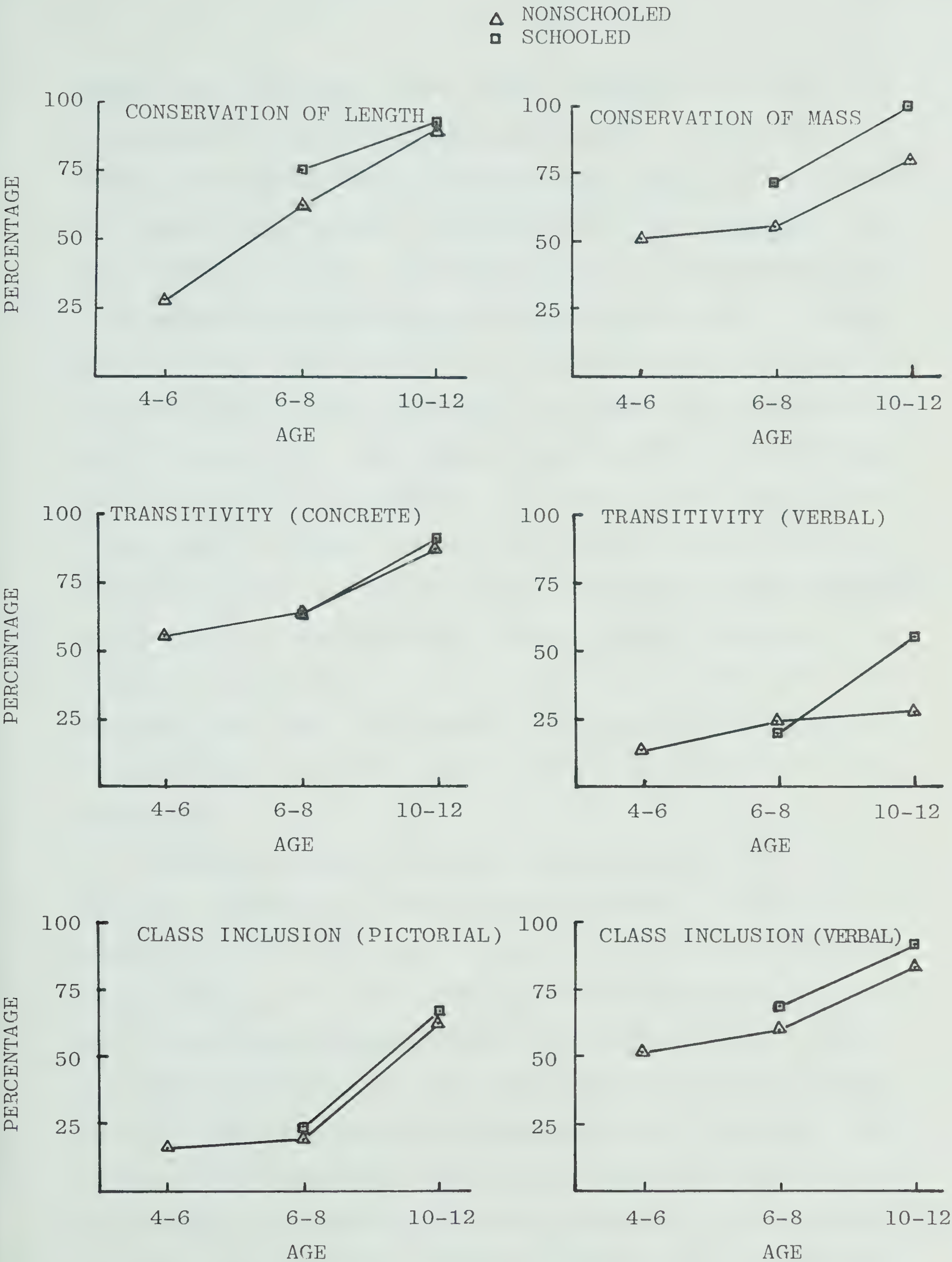

Figure 1. Percentage of schooled and nonschooled subjects in the acquisition stage for various Piagetian Tests.

operational concepts much faster and earlier compared to nonschooled children. Conflicting findings like these may partly be attributed to selection bias. Many studies failed to report the sample characteristics of schooled and nonschooled groups. Since the demographic characteristics that covary with schooling were left uncontrolled in these studies, it seems that the influence of schooling on concrete operational tasks might have been overestimated. In the present study, the schooled and nonschooled groups came from a relatively homogeneous sociodemographic background. There were also no linguistic or cultural barriers between the investigator and the subjects. Since the methodological requirements of some earlier studies (Kamara & Easley, 1977; Kiminyo, 1977; Nyiti, 1976) were satisfied, it was hypothesized that the present findings would be similar to that of theirs, and the results conformed closely to this hypothesis.

The percentage of subjects who attained the various concrete operational skills are plotted in Figure 1. In previous studies, the age of onset of a particular concrete operational skill has been regarded as the point at which 50% of the subjects are judged to have acquired that skill. Following the same criterion, the results of this study for the four nonverbal forms of Piagetian tasks revealed that transitivity and conservation of mass emerged around the age of 5 years and 3 months, and were followed by the attainment of the conservation of length at about 7 years of age. The

class inclusion concept was mastered much later, at about the age of 10. While the verbal mode of transitivity was mastered much later in comparison to its concrete form, this pattern was reversed for class inclusion performance. The fact that the verbal form of class inclusion is easier than its concrete form has been demonstrated in previous studies (Winer, 1974; Winer & Kronberg, 1974; Wohlwill, 1968). This finding which has been labeled "verbal facilitation effect" was presumably due to the absence of distracting perceptual cues present in the pictorial form of Class Inclusion.

Summary: In concluding this section, three important points should be mentioned. First, for all the Piagetian tests, significant effects of age were noted; neither the main effects of schooling nor its interaction with age were significant. Second, the various Piagetian tests used in this study were not homogeneous in measuring what Piaget labels as 'concrete operational skill'. Finally, the order of acquisition of the various concrete operational skills was as follows: conservation of mass, transitivity, conservation of length, and class inclusion.

Simultaneous-Successive-Planning Battery

The means and the standard deviations of the five groups on the simultaneous, successive, and planning tasks as well as for the Color Naming and the Word Reading tests are presented in Table 10. For the present study, the labeling of these tests as simultaneous (Figure Copying,

Table 10

Group Means and SDs of Simultaneous-Successive-Planning Battery and Color Naming and Word Reading Scores (N = 50 in each group unless otherwise specified)

Variables		4-6 Nsch	6-8 Nsch	6-8 Sch	10-12 Nsch	10-12 Sch
Figure Copying (FC)	Mean	5.48	7.72	9.08	9.30	13.86
	SD	2.08	2.89	2.59	3.52	2.21
Memory For Designs (MFD)	Mean	7.02	16.28	20.32	19.10	32.36
	SD	6.88	9.56	6.77	9.21	5.04
Digit Span (DS)	Mean	3.66	3.78	4.36	3.96	5.08
	SD	.71	.64	.68	.72	.77
Auditory Serial Recall (ASR)	Mean	19.92	19.93	28.60	24.92	40.20
	SD	8.79	8.68	7.42	10.26	8.56
Color Naming (CN)	Mean	130.60	110.28	81.74	96.98	56.60
	SD	39.79	24.94	26.62	34.89	17.78
Visual Search (VS)	Mean	7.24	6.25	5.94	6.45	4.79
	SD	1.97	1.83	1.61	1.83	1.41
Trail Making (Cards) (TMC)	Mean			7.36	7.34	6.05
	SD			.70 (N=26)	.62 (N=10)	.68
Trail Making (number) (TMN)	Mean			7.83		7.08
	SD			.48		.45
Word Reading (WR)	Mean			44.86		75.60
	SD			13.62		10.59

Memory for Designs), successive (Digit Span, Auditory Serial Recall), and planning (Visual Search, Trail Making) is ad hoc, and was done on the basis of the findings of earlier work (Ashman, 1978), because these tests have not been given to nonschooled children before. Evidence for their factorial validity will be presented later.

The mean Word Reading scores of 6-8 year old (Grade 2), and 10-12 year old (Grade 5) children revealed that the two groups were reading words at their respective grade levels. The mean scores for the Visual Search, and the Trail Making Tests are the group averages based on the logarithmic transformations of the original raw scores. For example, the original search time data for the four transparencies used in the Visual Search Test were transformed logarithmically, and were averaged to produce a single score for each subject. The group means were calculated on the basis of these transformed scores. The purpose in using the logarithmic transformation was to prevent any extreme reaction time score on a single trial from adversely influencing a subject's mean score. The same procedure was used to calculate the group means for the two forms of the Trail Making Test. The 4-6, and 6-8 year old nonschooled children could not do the 'card' form of the Trail Making Test. Only 26 schooled children in the 6-8 year age bracket, and 10 nonschooled children in the 10-12 year age group could complete the 'card' form of the Trail Making Test (Table 10).

Correlations and factor analyses: The correlations among these cognitive variables were calculated for each group separately and are available for inspection in Appendix III. Tables 11, and 12 present the pooled correlations of these cognitive variables for the three nonschooled and the two schooled groups respectively. Since the data for all the tests were complete only for the 10-12 year schooled group (Grade 5), a separate intercorrelation matrix for this group was obtained (Table 13). The pooled correlations in Tables 11, and 12 were calculated in the manner previously described.

As may be seen from the correlational data, the intercorrelations between Figure Copying and Memory for Designs, as well as that beween Digit Span and Auditory Serial Recall were very high. The pattern of the correlations among these tests was consistent for all the groups. The implications of the correlational data can be best examined from the pattern of varimax loadings of these tests to be presented next.

Principal components analyses were employed on the correlations presented in Tables 11, 12, and 13, and the factors with eigen values greater than 1 were rotated to the varimax criterion. The results of these analyses are presented in Tables 14, 15, and 16.

As may be seen from Table 14, three factors emerged. The first factor was defined by Figure Copying, and Memory for Designs, while the second one was defined by Digit Span,

Table 11

Intercorrelations (pooled) among Six Cognitive Variables for Nonschooled Groups (4-6 Nsch, 6-8 Nsch, 10-12 Nsch: N=150)

Variables	FC	MFD	DS	ASR	CN	VS
Figure Copying (FC)						
Memory For Designs (MFD)	.828					
Digit Span (DS)	.262	.301				
Auditory Serial Recall) (ASR)	.288	.331	.739			
Color Naming (CN)	-.222	-.234	-.290	-.226		
Visual Search (VS)	-.085	-.081	-.010	.005	.252	

Table 12

Intercorrelations (pooled) among Eight Cognitive Variables for Schooled Groups (6-8 Sch, 10-12 Sch: N = 100)

Variables	FC	MFD	DS	ASR	WR	CN	VS	TMN
Figure Copying (FC)								
Memory For Designs (MFD)	.651							
Digit Span (DS)	.063	.018						
Auditory Serial Recall) (ASR)	.049	.156	.732					
Word Reading (WR)	.070	.129	.132	.204				
Color Naming (CN)	-.118	-.220	-.249	-.296	.329			
Visual Search (VS)	-.043	-.087	-.006	-.167	-.059	.146		
Trail Making (Number) (TMN)	-.244	-.228	-.225	-.216	-.066	.270	-.074	

Table 13

Intercorrelations (pooled) among Nine Cognitive Variables for 10-12 Year Old Schooled (Grade 5) Group (N = 50)

Variables	FC	MFD	DS	ASR	WR	CN	VS	TMC	TMN
Figure Copying (FC)									
Memory For Designs (MFD)	.58								
Digit Span (DS)	-.06	-.01							
Auditory Serial Recall) (ASR)	-.08	.16	.70						
Word Reading (WR)	.16	.15	.39	.40					
Color Naming (CN)	-.02	-.24	-.30	-.29	-.28				
Visual Search (VS)	-.10	-.43	.05	-.17	-.28	.16			
Trail Making (Cards) (TMC)	.12	-.18	-.13	-.21	-.15	.36	.32		
Trail Making (Number) (TMN)	-.01	-.01	-.04	-.14	-.22	.33	.16	.23	

and Auditory Serial Recall. These two factors were labeled simultaneous, and successive processing respectively, and conform closely to the pattern established in previous research (Das, Kirby, & Jarman, 1975, 1979). The interpretation of the third factor was rather difficult, as the two tests (Color Naming and Visual Search) that load on this factor have been identified in previous research as defining 'speed' and 'planning' factors respectively. In several studies (Das, Kirby, & Jarman, 1975, 1979; Jarman, 1975; Kirby, 1976), Color Naming was found to be a 'speed' task, and in Ashman's (1978) study, Visual Search was taken as a measure of 'planning'. Thus, one would not expect these two tests to load on a single factor. The third factor might best be viewed as a 'speed' factor. However, in interpreting the 'speed' factor for this sample, one should not impose the connotation of the 'speed' factor obtained with the Canadian sample, on which earlier studies were based. The nonschooled subjects in the present sample were not very familiar with the names of the four colors. Some of the subjects took an extended series of practice trials to name the colors. Therefore, it may be viewed that color naming for this sample was a cognitive task demanding processing requirements which were not observed with the Canadian sample.

Four factors emerged when the principal components analysis was employed on the schooled children only (Table 15). The first two factors in Table 15 were defined as

Table 14

Principal Components Analysis with Varimax Rotation for the Nonschooled Groups (N = 150)

Variables	Factor I	Factor II	Factor III	h2
Figure Copying	.944	.131	-.084	.916
Memory For Designs	.934	.183	-.084	.912
Digit Span	.134	.915	-.084	.861
Auditory Serial Recall	.177	.899	-.030	.840
Color Naming	-.140	-.316	.692	.598
Visual Serach	-.024	.127	.863	.762
% of total variance	30.557	30.175	20.770	

Table 15

Principal Components Analysis with Varimax Rotation for the Schooled Groups (N = 100)*

Variables	Factors I	II	III	IV	h2
Figure Copying	-.017 (.023)	.880 (.911)	.015 (-.062)	.017 (.029)	.776 (.836)
Memory For Designs	.042 (.035)	.890 (.885)	-.003 (-.151)	-.088 (-.092)	.801 (.816)
Digit Span	.899 (.929)	-.026 (-.003)	-.007 (-.124)	.070 (.070)	.814 (.884)
Auditory Serial Recall	.907 (.909)	.063 (.066)	.018 (-.151)	-.142 (-.145)	.848 (.874)
Color Naming	-.361 (-.157)	-.220 (-.039)	.771 (.815)	.108 (.292)	.785 (.775)
Visual Serach	-.105 (-.054)	-.096 (-.061)	.060 (.026)	.920 (.931)	.869 (.874)
Trail Making (Number)	-.377 (-.143)	-.419 (-.227)	.173 (.725)	-.430 (-.323)	.532 (.702)
Word Reading	.263	.164	.845	-.067	.814
% of Total Variance	24.827 (24.845)	22.893 (23.936)	16.781 (17.927)	13.499 (15.597)	

* The loadings inside parentheses were obtained, when Word Reading Test was excluded from the battery

Table 16

Principal Components Analysis with Varimax Rotation for the 10-12 year old schooled sample (N = 50)

Variables	Factors I	II	III	h2
Figure Copying	-.075	.851	.190	.766
Memory For Designs	.084	.889	-.203	.839
Digit Span	.931	-.051	.038	.872
Auditory Serial Recall	.902	.057	-.196	.855
Visual Serach	.012	-.420	.662	.655
Trail Making (Cards)	-.155	.018	.766	.612
Trail Making (Number)	-.014	.095	.621	.395
% of Total Variance	24.554	24.396	21.834	

successive and simultaneous processing respectively. The factor loadings reported in parentheses in Table 15 were derived by excluding the Word Reading Test from the battery. The highest loading on the third factor was that of Word Reading Test, followed by that of Color Naming, and Trail Making (Number). This factor could be named 'school learning' factor as the tests that load on this factor demand skills taught in schools. The Color Naming task, as noted previously, also behaved as a cognitive task. The fourth factor may be labeled as 'speed of processing', which was defined by Visual Search, Color Naming, and Trail Making (Number). The pattern of results did not change when Color Naming was excluded from the battery. In all the previous forms of analyses, the simultaneous and successive processing factors emerged clearly. The Visual Search and Trail Making did not measure 'planning' as it did with the Canadian sample. One of the planning tasks, Trail Making (number) had moderate loadings on the simultaneous and succesive factors. The fact that the Word Reading score had a moderate correlation with the successive factor implies that successive processing is largely involved in word reading skill.

Table 16 reports the varimax loadings of seven tests on three significant factors. The first and the second factors were defined by the successive and simultaneous tasks respectively. The Visual Search, and the two forms of Trail Making loaded on the third factor. On the basis of the

findings reported in previous research, this factor could be labeled a 'planning' factor. When Word Reading and Color Naming Tests were included in the battery, the former had a considerably high loading on the 'successive' factor, and the latter had a moderate loading on the 'planning' factor (Appendix III). The correlation of Word Reading scores with successive processing indicated, once again, the importance of successive coding process in word reading skill.

In summarizing the factor analytic results, it should be noted that the emergence of simultaneous and successive processing as two independent factors was clear for all the groups. Secondly, for the nonschooled sample the emergence of a 'planning' factor was not possible. Finally, a 'planning' factor was established only for the older schooled (Grade 5) children. The results of these analyses closely conform to the hypotheses stated earlier except that it was not anticipated that the Color Naming task would be defined as a cognitive task at the same level as that of Visual Search and Trail Making.

For the nonschooled sample, a 'planning' factor did not emerge, as this factor was not completely independent of the Color Naming Test, which has been regarded in previous research as defining a 'speed' factor (Das, Kirby, & Jarman, 1975, 1979). In order for the Color Naming Test to be uncorrelated with the 'planning' factor, the naming of colors needs to be spontaneous and automatic. This criterion was not satisfied by the nonschooled sample in the present

study. Since, planning is a higher form of cognitive process, its emergence as a separate independent entity from a lower level skill such as color naming would only be possible for a sample, who can engage in complex cognitive operations. Conversely, the 'planning' factor was reduced to a factor called 'speed' for the nonschooled sample. But for the 10-12 year old schooled (Grade 5) children, the emergence of a 'planning' factor was somewhat clearer, as these subjects were capable of carrying a higher level of cognitive operation. In this respect, the findings were consistent with those of Ashman (1978), who was able to demonstrate the emergence of three independent factors, called simultaneous, successive, and planning with Grade 8 Canadian children.

Group differences: The factor analytic results provided a rationale for examining group differences on clusters of tests that define different processing requirements according to the information-integration model of Das, Kirby, and Jarman (1979). Accordingly, multivariate analyses of variance were employed for examining group differences on simultaneous and successive processing. Since, Visual Search and Trail Making did not cluster together for all the groups, the data for these tests were analyzed using one-way analyses of variance. The analytical procedure adopted to extrapolate the influence of schooling, age, and their interaction was identical to that described earlier in this section.

The results of the univariate and multivariate analyses of variance are presented in Tables 17, and 18. The main effects of schooling and age as well as their interaction were found to be significant for simultaneous and successive processing (Table 17). The significant interaction of schooling and age arises from the fact that the difference between schooled and nonschooled children becomes increasingly wider through successive years of schooling. For both the coding processes, the post-hoc contrasts revealed that schooled children performed at a significantly higher level than their nonschooled counterparts at both the age levels. Similarly, the simple effects of age were also significant for schooled and nonschooled samples on both coding processes. Compared to the preschooled children, the younger schooled group (Grade 2) was superior in both coding processes, whereas the younger nonschooled group was better only in simultaneous processing. Thus, the initial year of schooling had significant influence on both the coding processes, and more so on successive than on simultaneous. Comparison of 6-8 year old schooled (Grade 2) with 10-12 year old nonschooled children revealed that both were similar in simultaneous processing, but the former were superior in successive processing. This, once again, indicated a strong impact of schooling on successive processing.

The analyses of group differences on Visual Search and Color Naming are presented in Table 18. Since, Visual Search

Table 17

A Summary of 'F' Statistics from MANOVA Showing the Effects of Age (A) and Schooling (B) on Simultaneous and Successive Tasks

Source	df	Simultaneous	Successive
Age (A)	2	33.78**	21.92**
Schooling (B)	2	33.87**	47.54**
A X B	2	9.74**	4.04*
(6-8)Nsch vs (10-12)Nsch	2	4.37*	4.64*
(6-8)Sch vs (10-12)Sch	2	39.16**	21.33**
(6-8)Nsch vs (6-8)Sch	2	3.65*	12.15**
(10-12)Nsch vs (10-12)Sch	2	39.97**	39.43**
(6-8)Sch vs (10-12)Nsch	2	1.60	3.91* (Sch > Nsch)
(4-6)Nsch vs (6-8)Nsch	2	18.13**	< 1
(4-6)Nsch vs (6-8)Sch	2	36.63**	13.78**
Error	244		

* $p < .05$
** $p < .01$

Table 18

A Summary of 'F' Statistics from ANOVA Showing the Effects of Age (A) and Schooling (B) on Visual Search and Color Naming

Source	df	Visual Search	Color Naming
Age (A)	1	3.65	20.35**
Schooling (B)	1	15.70**	65.42**
A X B	1	7.37**	1.93
(6-8)Nsch vs (10-12)Nsch	1	<1	4.87*
(6-8)Sch vs (10-12)Sch	1	10.83**	17.41**
(6-8)Nsch vs (6-8)Sch	1	<1	22.44**
(10-12)Nsch vs (10-12)Sch	1	22.39**	44.91**
(6-8)Sch vs (10-12)Nsch	1	2.07	6.40* (Sch < Nsch)
(4-6)Nsch vs (6-8)Nsch	1	7.93**	11.37**
(4-6)Nsch vs (6-8)Sch	1	13.61**	65.76**
Error	245		

* $p < .05$
** $p < .01$

and Trail Making did not define a 'planning' factor in all groups, the interpretation of group differences on these tests will only be made with respect to the specific skills tapped by these tests.

For Visual Search, the significant influence of schooling as well as its interaction with age was noted; the effect of age was not significant. Further post-hoc contrasts revealed significant differences in this search skill beween the older schooled and nonschooled groups in favor of the former. The simple effect of age was significant only for the schooled population. Both the younger schooled and nonschooled groups were superior to the preschooled group in this test, which requires subjects to make analysis of many visual patterns and to find out the one that is similar to the target pattern. The results revealed that schooling influences the ability to make an analysis of the visual patterns, and in this respect the findings conform closely to those of Super (cited in Stevenson et al., 1978).

The performance on the Color Naming test, which has been labeled as a cogntive task for this sample, was influenced by both schooling and maturation. All the contrasts mentioned in Table 18 were significant except that schooling did not interact with age in influencing color naming ability. Since, for many subjects, the ability to name the colors was not spontaneous, they were given an extended series of practice trials to label the colors

appropriately. Hence, for this sample, group differences in color naming implies the speed of applying newly learned skills in test situations. So the influence of schooling and age on color naming ability should be made in the context of the skill measured by this test.

Since, the data for the two forms of Trail Making were not available for all the subjects, the analyses were confined to limited groups and a limited number of subjects. The number of subjects who were able to complete this test is given in Table 10. An ANOVA on Trail Making scores between 6-8 year old (Grade 2) and 10-12 year old (Grade 5) schooled children revealed a significant difference in favor of the latter ($F_{1,98} = 63.21$; $p<.01$). In the card form of the Trail Making Test, older schooled (Grade 5) children also performed at a significantly higher level in comparison to younger schooled (Grade 2) children ($F_{1,83} = 34.07$; $p<.01$). The younger schooled subjects were similar to the older nonschooled group ($F_{1,83} < 1$). The correlation beween the two forms of the Trail Making Test were .27, and .23 for the schooled children in younger and older age groups respectively. In summary, it can be said that the specific functional skill measured by Trail Making, i.e., the ability to form a linear ordering of a randomly presented set of stimuli, is considerably facilitated by schooling experience.

Summary: Before concluding this section, some important findings should be noted. First, simultaneous and successive

processing seemed to increase both as a function of age and educational experience. In this respect, the results were unlike those obtained with Piagetian concrete operational skills which improved with age but not as a function of schooling experience. Secondly, from the factor analytic investigation, simultaneous and successive processes appeared to emerge as two clearly and independently defined coding processes for all the groups. Thirdly, the Visual Search and Trail Making tests did not define a factor called 'Planning' in all the groups, as was obtained in earlier research (Ashman, 1978) with the Canadian sample. However, a factor similar to 'planning' emerged for the older schooled group. Fourthly, the functional skills assessed by these two tests (Visual Search and Trail Making) were found to be significantly influenced by schooling but not by maturation. Finally, the significant relationship between the word reading score and the two successive tasks indicated the importance of successive processing in reading skill, which is fostered in the first few years of schooling.

Clustering in Free Recall

Bousfield's (1953) ratio of repetition (RR) index was used in this study as the measure of clustering. A review of various measures of clustering (Dalrymple-Alford, 1970; Frankel & Cole, 1973; Frender & Doubilet, 1974; Hubert & Levin, 1980; Roenker, Thompson, & Brown, 1971; Shuell, 1969) dictated the adoption of Bousfield's measure of clustering

index for the reasons mentioned below. The three frequently used mesures of clustering are Bousfield's RR index, Frankel and Cole's Z score, and Roenker, Thompson and Brown's Adjusted Clustering Score (ARC). The formula used to compute Z score is not only complicated, but also does not specify fixed upper or lower boundaries of the Z scores. Furthermore, the Z score measure can sometimes underestimate the subject's use of categorical structure, as it does not take into account the number of categories in the original stimulus list (Frender & Doubilet, 1974). The adjusted ratio of clustering (ARC) score proposed by Roenker et al. (1971) suffers from similar difficulties. The appropriateness of the ARC score is also called into question in developmental research where a small number of items are frequently recalled. On the other hand, Bousfield's RR is independent of the number of words sampled, and its expected value can be determined by a simple formula.

Bousfield's RR is calculated by dividing the number of repetitions (r) in subjects' recall by (n-1), where 'n' is the number of words in the recall output. Shuell (1969), using some actual data, showed that the RR index had a smaller correlation with the number of words recalled than did other clustering indices with which he compared it. Besides having these desirable properties, the RR index correlates in the high .90s with the Z score advocated by Frankel and Cole (1971). In the light of this evidence, it was considered desirable to use the RR formula in scoring

the recall protocols. It was also found in the present study that the RR measure had a near zero correlation ($r = .037$) with the length of the recall output on the 3rd trial over all the groups.

The mean clustering scores of the five groups before (3rd trial) and after (4th trial) verbal cuing are reported in Table 19 and are plotted in Figure 2. A 2 (age) X 2 (schooling) X 2 (repeated measures on 3rd and 4th trials) was employed to analyze the data. The results of this analysis are presented in Table 20.

Both age and schooling interacted with the repeated measures, i.e., the clustering index obtained before and after verbal cuing was done. Further post-hoc contrasts revealed that there were no significant differences between the schooled and nonschooled groups ($F1,96 = 1.10$, $p>.05$), or between younger and older subjects ($F1,96 <1$) in the clustering index before verbal cuing was done. However, as a result of verbal cuing, recall output tended to show increased clustering for the schooled ($F1,96 = 5.49$, $p<.05$), but not for the nonschooled children ($F1,96 <1$). Similarly, older children profited from verbal cuing ($F1,96 = 16.29$, $p<.001$), while younger children did not ($F1,96 = 1.08$, $p>.05$). The maximum improvement in clustering was noticed for the older schooled children.

Although, grade is a key variable associated with spontaneous clustering of the recall output, its effect does not become prominent until subjects have experienced some

Table 19

Group Means and Standard Deviations of Clustering Scores Before and After Verbal Cuing (N = 25 in each group)

Groups	Before Verbal Cuing (3rd Trial)		After Verbal Cuing (4th Trial)	
	Mean	SD	Mean	SD
(4-6) Nonschooled	.35	.15	.34	.14
(6-8) Nonschooled	.40	.12	.38	.15
(6-8) Schooled	.37	.13	.43	.11
(10-12) Nonschooled	.38	.11	.45	.12
(10-12) Schooled	.41	.13	.53	.16

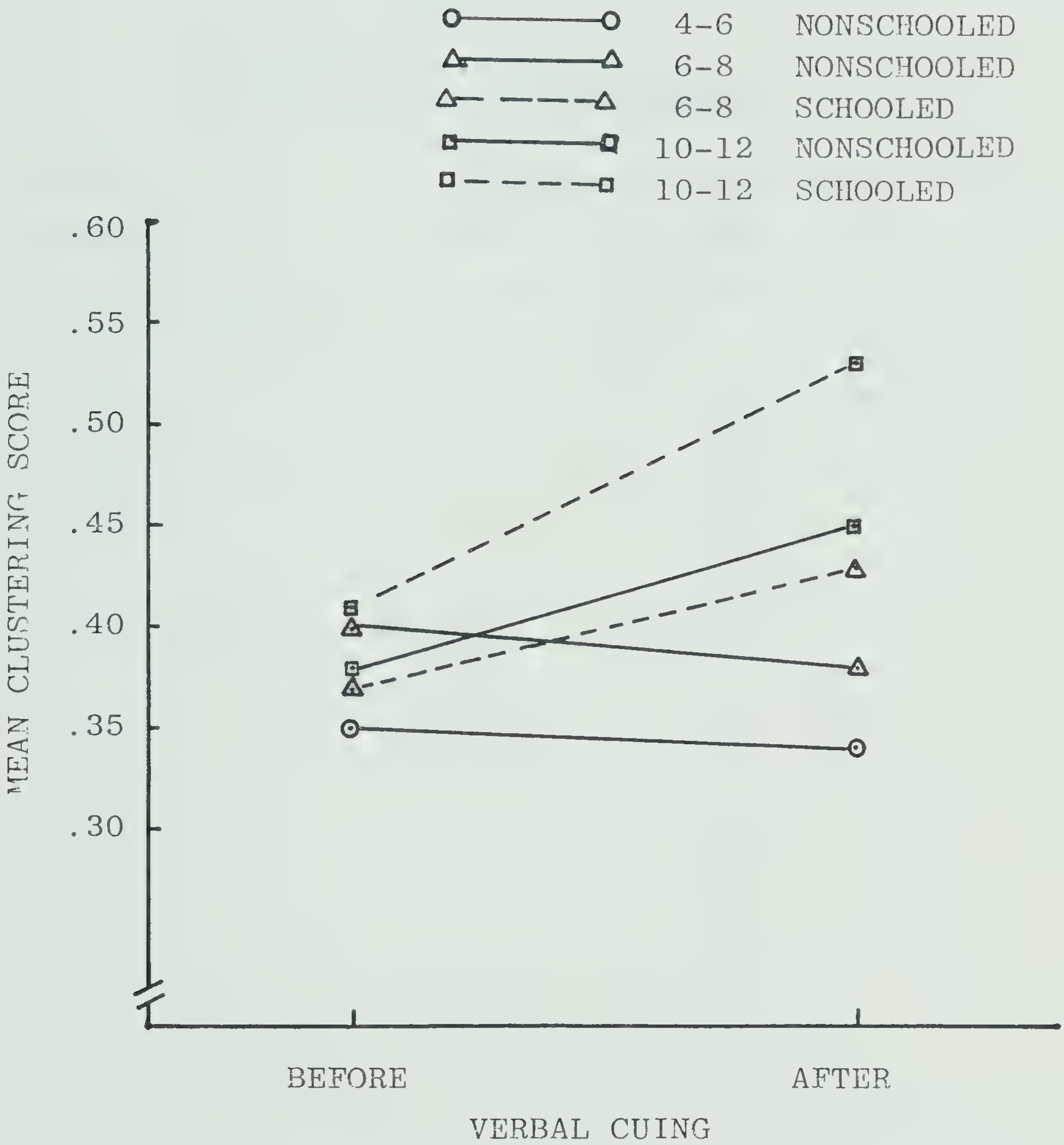

Figure 2. Mean clustering scores of five groups before (3rd trial) and after (4th trial) verbal cuing.

Table 20

Summary of Analysis of Variance
for Clustering in Free Recall

Source	df	MS	F
Between Subjects	99		
Age (A)	1	.130	5.88*
School (B)	1	.036	1.65
A X B	1	.027	1.24
Subj w grp	96	.022	
Within Subjects	100		
Trials (C)	1	.172	12.88**
A X C	1	.060	4.49*
B X C	1	.063	4.69*
A X B X C	1	.005	.38
C X Subj w grs	96	.013	

* $p < .05$
** $p < .01$

amount of secondary level education. In this respect the finding of the present study is consistent with that of other researches conducted in Liberia, and Mexico (Cole et al., 1971; Sharp et al., 1979). The data, however, did not support the findings of Cole and his associates with regard to the effect of verbal cuing on the semantic organization of the recall output. They observed that providing the Liberian subjects (grades 2 to 6) with category names both at the time of presentation and recall did not enhance clustering in their recall output. The results of the present study revealed that schooled subjects with a range of 2-5 years of education could reliably use the experimenter's classification scheme, when provided with the category names at the time of presentation and recall, but there was no reliable increase in the length of the recall output as a result of verbal cuing. By providing the category names, the experimenter made explicit the structure of the stimulus array, which the schooled children could utilize to their advantage, but the nonschooled children could not.

It is rather difficult to tell whether improvement in clustering was due to the school children's ability to follow experimenter's instructions or it was due to a generalized effect of the formal linguistic system enforced in schools, which the experimenter evoked by supplying category names. The results, however, demonstrated that while both schooled and nonschooled groups failed to

spontaneously utilize the semantic information of the stimulus list as a means of organizing recall, it was only the schooled children who showed sensitivity to the semantic structure, when it was made explicit to them.

In the fifth trial (constrained recall), the subjects were told the category names at the time of presentation and recall, and were asked to recall all the items from one category, which was then followed by asking subjects to recall items from a second category, and so on. Because, constrained recall shows perfect clustering by definition, the importance of this trial was to examine the relative influence of age and schooling on the number of words recalled.

The analysis of variance employed on the number of words recalled on the fifth trial revealed a significant effect of age ($F1,120 = 25.61$, $p<.001$); neither the main effect of schooling ($F1.120 <1$), nor its interaction with age ($F1,120 <1$) was significant. The mean number of items recalled by the two schooled and two nonschooled groups under this constrained recall procedure were 12.96, and 12.48 respectively. Thus, the length of the recall output remained unaffected by 2-5 years of formal educational experience, while a significant developmental trend was noticed in this respect.

Summary: In summary, consistent with the findings of Cole and his associates, schooled children with a range of 2-5 years of formal education were not superior to their

nonschooled counterparts in demonstrating spontaneous clustering. But unlike their observation, verbal cuing at the time of presentation and recall resulted in improved clustering for the schooled but not for the nonschooled children in the present sample. No significant differences were observed between schooled and nonschooled groups with respect to the number of words recalled when the category names were explicitly provided by the experimenter. Thus, the influence of schooling was not observed either with respect to the length of the recall output, or in the spontaneous utilization of the semantic information of the stimulus list to be remembered. When the stimulus array was partially structured by providing category names as cues, only the schooled children could effectively utilize this information towards enhancing clustering in the recall output.

Serial Short-Term Recall of Locations

The group means and the standard deviations for the overall recall as well as for the primacy, middle-positions, and the recency recall are presented in Table 21, and plotted in Figure 3. The statistical procedure used to obtain the main effects of schooling, age and their interactions was identical to that described earlier. Post-hoc contrasts were used to obtain the simple effects of age and schooling and to further specify differences between relevant groups. The 'F' values yielded by these anlayses

Table 21

Group Means (proportion correct) and SDs
for Serial Short-Term Recall
(N = 25 in each Group)

Groups		Total	Primacy	Middle-Positions	Recency
(4-6)	Mean	.42	.39	.24	.73
Nonschooled	SD	.12	.26	.15	.20
(6-8)	Mean	.48	.46	.32	.73
Nonschooled	SD	.10	.22	.19	.20
(6-8)	Mean	.49	.37	.37	.79
Schooled	SD	.10	.28	.17	.19
(10-12)	Mean	.51	.57	.33	.73
Nonschooled	SD	.11	.30	.18	.20
(10-12)	Mean	.53	.48	.39	.78
Schooled	SD	.11	.26	.19	.17

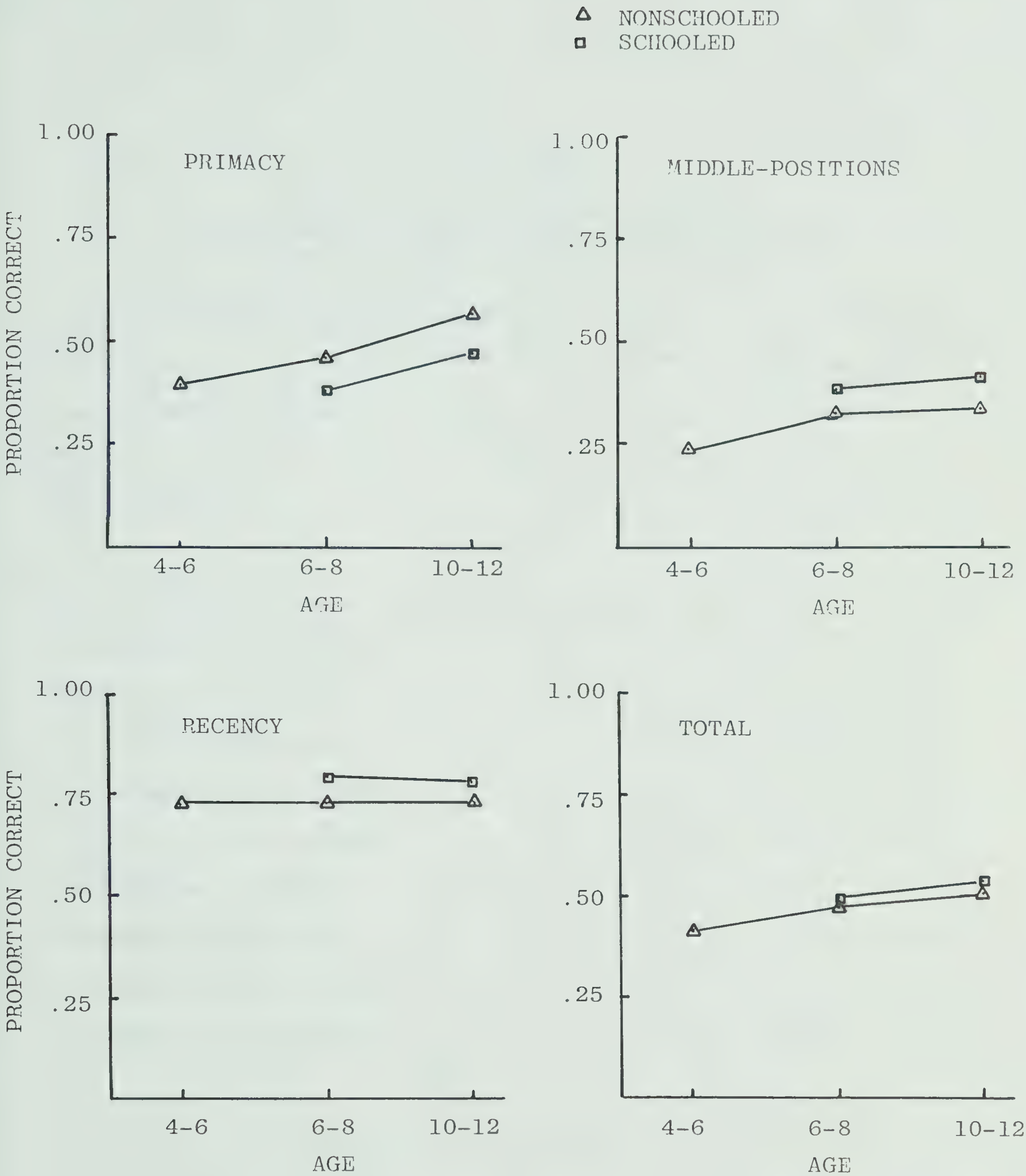

Figure 3. Primacy, Middle-positions, recency, and total recall of five groups.

Table 22

A Summary of 'F' Statistics Showing
the Effects of Age (A) and Schooling (B) on
Serial Short-Term Recall Measures

Source	df	Total	Primacy	Middle Position	Recency
Age (A)	1	2.66	4.25*	.14	.02
Schooling (B)	1	.34	2.84	2.33	2.02
A X B	1	.01	0.00	.04	.02
(6-8)Nsch vs (10-12)Nsch	1	1.23	2.13	.02	0.00
(6-8)Sch vs (10-12)Sch	1	1.44	2.13	.16	.03
(6-8)Nsch vs (6-8)Sch	1	.14	1.42	.89	1.21
(10-12)Nsch vs (10-12)Sch	1	.21	1.42	1.47	.84
(6-8)Sch vs (10-12)Nsch	1	.55	7.03**	.65	1.21
(4-6)Nsch vs (6-8)Nsch	1	3.07	.86	2.61	0.00
(4-6)Nsch vs (6-8)Sch	1	4.51*	.07	6.54*	1.21
(4-6)Nsch vs (10-12)Nsch	1	8.19**	5.69*	3.06	.00
(4-6)Nsch vs (10-12)Sch	1	11.04**	1.42	8.77**	.84
Error	120				

* $p < .05$
** $p < .01$

are presented in Table 22.

The main effects of schooling, and age as well as their interactions were not significant for the overall recall. Further analyses revealed that neither the simple effects of age nor schooling was significant (Table 22). Compared to the 4-6 year old nonschooled children, the remaining four groups except 6-8 year old nonschooled children were higher in their overall recall. Thus, the general memory proficiency increased as a function of age in the 5-7 year age bracket, and remained invariant with age thereafter. No significant differences were observed between schooled and nonschooled groups, and in this respect the findings were in accordance with those of Wagner (1978), who found no significant influence of schooling before the age of 12.

Of special interest to the study were the within-trial sources of varying effects of age and schooling. As expected, the mean recency recall was higher in comparison to the primacy and middle-positions recall in all the groups. The serial position data obtained with the present sample replicated the studies of Wagner (1974, 1978). The recency recall does not require a spontaneous application of active cognitive strategies as items at the end of the list can be retrieved more or less automatically from short-term or 'echoic' memory (Hagen, 1971). The results were consistent with previous research in that the recency recall, which is regarded as a measure of structural features of memory remained invariant with age or schooling

experience. It seems plausible, and is consistent with previous research that recency or 'echoic' memory may be a universal memory phenomenon, which can be effectively utilized by young and old, schooled and nonschooled subjects.

For primacy recall, there was a significant main effect of age only, thus suggesting a developmental trend in the primacy effect, which has been regarded as a measure of control processes in memory (Atkinson & Shiffrin, 1968). Further simple effects tests revealed no significant differences between the schooled and the nonschooled groups at either age level. Since the primacy effect is closely related to verbally mediated rehearsal strategies, it is suggested that 2 to 5 years of formal education does not reliably increase the use of such active cognitive strategies. Wagner also did not observe the influence of schooling on control processes before the age of 12 years. The data, however, did not support Wagner's view that higher level memory strategies such as rehearsal develop as a function of education, and not of maturation alone. The significant effect of age suggested that age-related changes in control processes of memory such as rehearsal may occur as a function of age only.

Summary: In summary, three important findings should be noted. First, the serial position curves obtained with the present sample replicated the studies of Wagner. Second, as expected and consistent with the previous research the

structural aspects of memory as reflected in recency recall performance remained invariant with age or schooling experience. Thirdly, it was found that age in the absence of schooling may contribute towards the development of control processes in memory such as rehearsal which is closely linked with the primacy effect.

Syllogistic Reasoning

The means and the standard deviations of the five groups for seven different types of syllogisms are presented in Table 23. The results of the analyses of variance for each type of syllogism as well as for the total are given in Table 24. The statistical procedure adopted to obtain the main effects of schooling and age as well as their interaction was identical to that described earlier.

For the total number of syllogisms solved, the main effect of age was significant, thus implying a developmental trend in verbal-logical reasoning ability; however, neither the main effects of schooling nor its interaction with age was significant. The results indicated that schooled and nonschooled children did not differ in the total number of syllogisms, they were able to solve.

The interaction of schooling and age was not significant for any of the seven different types of syllogisms. Significant effects of age were obtained only for the unfamiliar and the conjunctive types. Comparison of schooled and nonschooled groups on various types of

Table 23

Group Means and Standard Deviations
for Syllogisms (N = 30 in each group)

Syllogisms		4-6 Nsch	6-8 Nsch	6-8 Sch	10-12 Nsch	10-12 Sch
Total	Mean	10.30	10.57	10.83	11.17	11.73
	SD	2.12	1.48	1.93	1.34	1.98
Familiar	Mean	1.90	1.77	1.83	1.63	1.83
	SD	.30	.54	.38	.56	.38
Unfamiliar	Mean	1.50	1.67	1.60	1.87	1.97
	SD	.57	.55	.50	.35	.18
Artificial	Mean	1.33	1.67	1.60	1.90	1.63
	SD	.80	.66	.77	.31	.67
Contrary to experience	Mean	1.57	1.43	1.03	1.40	1.10
	SD	.50	.72	.80	.67	.80
Conjunctive	Mean	1.17	.67	1.43	1.17	1.77
	SD	.75	.60	.73	.79	.57
Disjunctive	Mean	1.73	1.73	1.77	1.73	1.93
	SD	.52	.45	.43	.45	.25
Implicative	Mean	1.10	1.63	1.57	1.47	1.50
	SD	.76	.49	.73	.63	.73

Table 24

A Summary of 'F' Statistics from ANOVA Showing the Effects of Age (A) and Schooling (B) on Syllogistic Reasoning

Source	df	Total	Familiar	Unfamiliar	Artificial	Contrary to exp.	Conjunctive	Disjunctive	Implicative
Age (A)	1	5.22*	<1	11.60**	1.15	<1	11.03**	1.01	<1
Schooling (B)	1	1.56	2.67	<1	1.97	7.21**	28.90**	2.27	<1
A X B	1	<1	<1	1.03	<1	<1	<1	1.01	<1
(6-8)Nsch vs (10-12)Nsch	1	1.67	1.41	2.92	1.84	<1	7.80**	<1	<1
(6-8)Sch vs (10-12)Sch	1	3.77	<1	9.81**	<1	<1	3.47	2.25	<1
(6-8)Nsch vs (6-8)Sch	1	<1	<1	<1	<1	4.73*	18.33**	<1	<1
(10-12)Nsch vs (10-12)Sch	1	1.49	3.18	<1	2.41	2.66	11.23**	3.24	<1
(4-6)Nsch vs (6-8)Nsch	1	<1	1.41	2.03	3.76	<1	7.80**	<1	9.37
(4-6)Nsch vs (6-8)Sch	1	1.32	<1	<1	2.41	8.41**	2.22	<1	7.18
Error	145								

* $p < .05$
** $p < .01$

syllogisms revealed that the schooled children were superior in solving conjunctive syllogisms, whereas the nonschooled children were better in solving syllogisms that were contrary to experience. For all other types of syllogisms, no significant differences were obtained between the schooled and nonschooled groups.

An examination of the simple effects of age and schooling for the conjunctive type revealed that schooled children were superior to their nonschooled counterparts at both age levels, and that older children did better than younger children only in the nonschooled sample. For the syllogisms that were contrary to subjects' experience, the simple effect of schooling was significant for the younger age group in favor of the nonschooled children.

The present findings are not in accordance with those obtained from earlier research (Cole, Gay, Glick, and Sharp, 1971; Fobih, 1979; Luria, 1976; Scribner, 1977; Sharp et al., 1979). In all the previous researches, schooling has been demonstrated to be a variable favorably influencing subjects' ability to solve verbal-logical problems. However, the basis for the superiority of schooled children in verbal-logical reasoning was by no means clear. It was speculated that differences in syllogistic reasoning is not in terms of logical reasoning, but rather in subject's willingness to accept a syllogism as a self-contained problem from which inferences can be drawn (Rogoff, 1981). Thus, refusal of the basic premise, which reflects subjects'

unwillingness to treat the syllogistic reasoning task as a self-contained hypothetical problem would result in an incorrect solution. Some of the schooled children in the present sample were unwilling to accept the basic premises read out by the experimenter, as these premises were not congruent with their knowledge acquired in school. The syllogisms that were contrary to experience provided situations, where the schooled children applied their school-based learning to refute the basic premises, and hence did poorly in comparison with nonschooled children.

Similarly, for the syllogisms in the 'artificial' category, schooled children were slightly inferior to their nonschooled counterparts. In response to a problem such as "Those having legs can walk; if trees would have legs, would they be able to walk or not?", some schooled children replied "No". They justified their response by saying that "trees depend on soil for their food, which they gather through their roots. If they would start walking, the roots would be severed, in which case they would die." Similarly, the problem, "Those having wings can fly; If dogs would have wings, would they be able to fly or not ?", was incorrectly solved by 20% of the 10-12 year old schooled (grade 5) children, whereas all the 10-12 year old nonschooled children were able to solve it correctly. When asked for justification, some of the schooled children brought in their school-based knowledge, and made a comparison of the bone structure and weight of dogs and birds. Since, birds

have lighter bone, and weigh less compared to dogs, it was judged that only birds can fly and dogs cannot. Thus, schooled children were unwilling to treat some syllogisms as self-contained logical units, and brought in their normative knowledge acquired in schools either to refute or judge the validity of certain premises. The refusal of the basic premises was not possible for the conjunctive type of syllogisms. Therefore, schooled children responded to the rules contained in the premises, and were superior to nonschooled groups. The results indicated that school learning may not always be facilitatory in its effect in solving certain kinds of syllogisms. Consistent with the present finding, Bickersteth (1979) observed similar response patterns among Grade 4-6 children in Sierra Leone.

Some schooled subjects and older children treated the syllogistic reasoning task as representing a problem situation that required a solution, rather than as a question to be answered on the basis of the rules contained within the premises. Wherever possible, the schooled children considered the experimental setting as a situation where they could demonstrate their school-based knowledge to the experimenter. One syllogism in the implicative category read, "So that Rama Babu might be able to carry rice from his village to the nearest town, he needs a cart and some bags; he has the bags, but he does not have the cart; can he carry his rice or not?" The older and the schooled subjects solved the problem by saying "Yes, he can carry his rice by

hiring a truck, or borrowing a cart from his neighbor." They were assimilating the problem contents into their personal experience in terms of what they could do, if they were faced with a problem situation like the one posed by the experimenter.

There were five syllogisms for which school based learning interfered with a correct solution: one in the 'familiar' category, two that were 'contary to experience', and two that were 'artificial'. One syllogism in the implicative category was perceived as a problem situation that needed to be solved. The mean performance of the schooled subjects in these syllogisms was slightly poorer than that of nonschooled groups (Table 23). Therefore, their overall score was depressed, and no significant difference was observed between the schooled and nonschooled groups.

The data of the present study suggest that four years of formal education in this culture does not significantly improve verbal-logical reasoning on these tasks. However, one might possibly argue that the problems were easy compared to those used by previous researchers, and therefore, were not sensitive enough to capture the influence of schooling. It may be seen from Appendix I that the nature and format of the items used in the present study was highly similar, and in some cases identical to those used by previous investigators (Bickersteth, 1979; Fobih, 1979; Luria, 1976; Sharp et al., 1979). Since there was no prior knowledge with regard to how these subjects would

'handle' syllogisms, the content and the format of the items were deliberately chosen to be similar to that of other research . It is, therefore, suggested that a relatively difficult set of items, possibly in the format of classical syllogisms (Scribner, 1975) should be used in future research in order to isolate the effect of age and schooling.

According to Luria (1971), verbal-logical reasoning is a fundamental and basic aspect of cognition, which is shaped by the socio-historical experiences of the subjects. On the basis of this assumption, how would one expect 3 to 4 years of formal schooling to completely alter the characteristics of such a basic cognitive mechanism? Unless the mechanism by which a relatively low level of education can effect such a radical change can be specified, the cognitive superiority of schooled children might always be attributed to factors that covary with schooling. On the other hand, the contribution of specific cultural experiences may appear to be important as cultures differ in the way they 'amplify', or 'modify' processes of cognition. This statement is also borne out by Sharp et al.'s (1979) observation that ...

> some experience other than education, however, must influence responses in this kind of situation because the Mayan adults from Ticul (Mexico) respond significantly better from a comparable population from the smaller, more traditional town of Ramonal (p.54).

So far as the present finding is concerned, an absence of schooling effect could be attributed to a relatively higher level of performance of nonschooled children in comparison to that reported in other studies. In terms of overall performance, the mean success rate for any of the groups was less than 74%. The mean correct response for the two nonschooled groups in the age bracket of 6-12 years was 78%, which is identical to the performance level of Grade 4-6 students in Ticul, Mexico (Sharp et al., 1979), and higher than the 68% success rate for Grade 4-6 Ghanaian students (Fobih, 1979). The mean performance level of the nonschooled subjects was similar to that obtained with Grade 4-6 sample of Sierra Leone and Canada (Bickersteth, 1979), and higher than that observed by Luria (1976) with the illiterate adults in Central Asia.

The variability in performance of nonschooled children was also lower than that obtained by Fobih, and Bickersteth, which indicates the level of consistency of the present sample of subjects in responding to verbal-logical problems. On the basis of this evidence, one should be cautious in making generalizations about the performance characteristics of nonschooled subjects. On the other hand, future research should focus on what possible experiential variable is likely to account for the performance level of the present nonschooled subjects. The data support a between-culture variation in syllogistic performance, which follows from Luria's (1976) conception that processes of cognition are to

a large extent shaped by socio-historical experiences.

All the subjects in the present sample were asked to justify their answers. In most cases, the answers were very short and precise verbal explanations, and it was not possible to mark them as either 'theoretic', or 'empiric', using the criterion of Scribner (1977). The difficulties in distinguishing between a 'theoretic' and 'empiric' response have been discussed in the 'review of literature' section. It should be mentioned that in a previous study (Sharp et al., 1979), the percentage of theoretic justifications was closely linked with the percentage of correct answers. The rank order properties of the seven groups studied by Sharp et al. (1979) which varied in age and educational experience remained invariant, when judged on the basis of either percentage of correct answers or theoretic justifications; there was a maximum difference of five points for any group studied. In the light of this evidence, one could argue that nothing more would have been learned about the rank order properties of the five groups in the present study by applying a theoretic-empiric dichotomy on the recall protocols.

Several example responses from previous investigations indicated that some of the illiterate and nonschooled subjects refused to answer the problem, as its content was not congruent with their practical world knowledge. For example, in response to 'snow and color of the bears' problem, illiterate subjects refused to draw any inference

as they were acquainted neither with such unfamiliar places nor with the bears present there. In some cases, they brought in their personal world knowledge to completely alter the contents of the major and minor premises, which resulted in an incorrect solution. None of the subjects in the present sample refused to answer a problem. However, for some subjects in the present study, their past experiences dictated the answers, but not to the extent that the major or minor premise was completely altered to fit into their empirical world knowledge.

Summary: In summary, the data supported a developmental trend but failed to register a significant influence of schooling on syllogistic reasoning performance, which has been regarded as a system of 'theoretical thinking', and a fundamental process in cognition. Secondly, the results indicated that generalizations concerning poorer performance of nonschooled subjects should be made with caution, as their performance characteristics are not universally found across all cultures. Thirdly, it was demonstrated that school experience may not always be helpful in solving certain kinds of syllogisms, especially those where the problem contents are contrary to the knowledge-base acquired in schools.

Relationship between Simultaneous-Successive Processing and Concrete Operational Skills

The raw scores on two simultaneous and two successive tests of 125 subjects who took Piagetian tasks (25 subjects in each group) were submitted to a principal components analysis. The varimax loadings on the simultaneous and successive factors were used to calculate the factor scores for each subject. These two factor scores were then correlated with six Piagetian tests. A similar procedure was also used to analyze the data for the three nonschooled groups. These correlations are given in Table 25. The six Piagetian skills correlated more highly with the simultaneous factor scores than with successive. The results indicated that simultaneous rather than successive processing was involved in solving Piagetian tasks at the concrete operational level.

On the basis of the factor scores, a double median-split procedure was used to divide subjects into four groups: high simultaneous-high successive, high simultaneous-low successive, low simultaneous-high successive, and low simultaneous-low successive. Those who scored above the median were considered high in the respective modes of processing, whereas those who scored below the median were considered to be low in the respective modes. The division of the subjects into four groups was carried out on the entire sample and also on the nonschooled subjects separately. The means and the standard deviations

Table 25

Intercorrelations of Simultaneous and Successive Factor Scores with Piagetian Tests

	Cons. Length	Cons. Mass	Trans. (Concr)	Trans (Verbal)	Cl.Incl (Pict)	Cl.Incl (Verbal)
			Entire Sample (N = 125)			
Simultaneous	.334	.350	.320	.275	.324	.250
Successive	.113	.040	.056	.053	.078	.216
			Nonschooled Sample (N = 75)			
Simultaneous	.283	.295	.265	.175	.145	.034
Successive	-.045	-.148	.041	-.211	.085	-.025

Table 26

Means and SDs of Four Groups on Piagetian Tasks

Groups		Cons. Length	Cons. Mass	Trans. (Concr)	Trans. (Verb)	Cl.In. (Pict)	Cl.In. (Verb)
		Entire Sample (N = 125)					
High Simul-High Succ (N = 31)	Mean	3.47	1.75	4.31	2.22	2.75	3.50
	SD	1.29	.67	.93	1.04	1.46	.98
High Simul-Low Succ (N = 31)	Mean	3.52	1.74	4.29	2.06	2.23	2.77
	SD	1.18	.63	.97	.89	1.38	1.12
Low Simul-High Succ (N = 31)	Mean	2.68	1.29	3.87	1.52	1.55	2.74
	SD	1.49	.90	1.12	1.12	1.26	1.15
Low Simul-Low Succ (N = 32)	Mean	2.74	1.39	3.71	1.71	1.65	2.84
	SD	1.79	.80	1.19	1.07	1.38	1.29
		Nonschooled Groups (N = 75)					
High Simul-High Succ (N = 18)	Mean	3.50	1.89	4.33	1.61	2.11	2.84
	SD	1.20	.32	.91	1.04	1.60	1.38
High Simul-Low Succ (N = 19)	Mean	3.42	1.68	4.00	2.05	2.37	2.84
	SD	1.39	.67	.94	.91	1.46	1.17
Low Simul-High Succ (N = 19)	Mean	2.05	.79	3.58	1.21	2.05	2.68
	SD	1.35	.92	1.12	1.18	1.08	1.06
Low Simul-Low Succ (N = 19)	Mean	2.26	1.26	3.58	1.63	1.16	2.52
	SD	1.94	.87	1.39	.96	1.17	1.47

of these four groups on the six Piagetian tests are presented in Table 26. Since the medians of the groups are sample-dependent statistics, one could have used the random-model analyses of variance to examine the relationship of coding processes with Piagetian variables. It should be pointed out that in most cases the interaction terms were very low, and therefore, the results of the random-model analyses of variance would be essentially similar to that reported in Table 27. The presence of significant interactions with the absence of main effects (verbal class inclusion for the entire sample), and with the presence of a strong main effect (Conservation of Mass for the nonschooled sample) provide situations where the results would also have been similar to that reported in Table 27, if the random-model analyses of variance would have been used.

The purpose of the study was to examine if preference for the simultaneous or successive mode of processing influences performance on concrete operational tasks. Accordingly, 2 (simultaneous) X 2 (successive) fixed-model analyses of variance were performed, and the results are shown in Tables 27.

As may be seen from Table 27, no significant influence of successive processing was obtained for any of the concrete operational tasks. Except for the two verbal forms (Class Inclusion and Transitivity), the main effects of simultaneous processing were consistently significant for

Table 27

A Summary of 'F' Statistics Showing the Effects of Simultaneous and Successive Processing on Piagetian Tasks

Source	df	Cons. Length	Cons. Mass	Trans. (Concr)	Trans (Verb)	Cl.Incl (Pict)	Cl.Incl (Verb)
			Entire Sample (N = 125)				
Simul. (A)	1	9.03**	9.00**	7.31**	8.16**	13.16**	2.89
Succ. (B)	1	.04	.11	.24	.01	.76	2.37
A X B	1	.00	.15	.14	.88	1.60	4.06**
Error Var.	121						
			Nonschooled Sample (N = 75)				
Simul. (A)	1	14.13**	19.86**	5.27*	3.00	4.20*	.62
Succ. (B)	1	.03	.62	.43	3.31	1.06	.06
A X B	1	.17	3.95*	.42	.01	3.46	.08
Error Var.	71						

* p < .05
** p < .01

all the Piagetian tasks. The analyses, based on the entire sample, showed a significant effect of simultaneous processing on the verbal form of transitivity. According to Piagetian theory, a nonverbal mode of presentation is recommended for assessing concrete operational skills. In view of the fact that only the main effects of simultaneous, and not successive processing were significant for all the four nonverbal tasks, the results indicate an involvement of simultaneous processing in solving tasks at the concrete operational level.

The means of the high simultaneous-low successive group were consistently higher for all the Piagetian tests compared to that of low simultaneous-high successive group. An examination of the table of means suggests that those who were low in both coding processes were better in two conservation tasks and verbal transitivity than those who were low in simultaneous but high in successive. For the analyses done on the entire sample, the performance superiority of the low simultaneous-low successive group was also maintained for the two forms of class inclusion task. Therefore, successive processing, instead of becoming facilitatory in its effect, may in some cases become a liability, while solving Piagetian concrete operational tasks.

As may be seen from Table 27, the interaction of simultaneous and successive processing was significant for the Conservation of Mass in the nonschooled group. This is

attributed to the superior performance of the low simultaneous-low successive group over the low simultaneous-high successive group ($F_{1,71} = 13.68$, $p<.01$). The results, once again, support the view that a predominant preference for the use of simultaneous over successive processing may be advantageous in acquiring the concrete operational concepts. However, it was only for the verbal form of Class Inclusion that involvement of both the processes was essential.

For the verbal form of transitivity, where the subject was asked the questions of the form, "Mr. X is taller than Mr. Y; Mr. Y. is taller than Mr. Z; who is taller, X or Z?", a significant involvement of simultaneous processing was found. Questions of this type have been used by several researchers as a measure of syllogistic reasoning (Sternberg, 1980; Heemsbergen, 1980). The Transitivity task is similar to a Syllogistic Reasoning task in the sense that both require subjects to draw a correct inference on the basis of verbal-logical relations contained in the problem. The present study also used syllogistic reasoning problems, the results of which are reported in the next section. It was found that the involvement of simultaneous processing was essential for solving both verbal transitivity and syllogistic reasoning problems. The relationship of simultaneous synthesis with performance on tasks that are purely verbal in form carries a significant implication for the simultaneous-successive model of Das, Kirby, & Jarman

(1979). Although, simultaneous processing is quasi-spatial in nature, and is assessed by tasks that are nonverbal in form, as a cognitive process, it underlies the competence in both verbal and nonverbal domains of human behavior.

The findings of the present study are in accordance with earlier research (Cummins & Das, 1978; Mwamwenda, 1981) in that simultaneous processors have an apparent advantage over successive processors in solving concrete operational tasks. Similarly, Carlson and Weidl (1977) found support for viewing concrete operational tasks as instances where simultaneous processing was required.

The processes underlying Piagetian tasks have been recommended for study by several authors (Flavell, 1977; Thayer & Collyer, 1978; Winer, 1980). Basic to all the concrete operational tasks is the children's ability to integrate information from several sources in order to arrive at a correct judgment, and the manner of this integration seems to be compatible with the characteristics of simultaneous and not successive processing. The central notion in concrete operations appears to be reversibility, which is a logical-spatial concept like simultaneous synthesis.

In transitivity, a correct solution is attained by creating a spatial representation of the elements to be compared. It involves an internalization of the concept of the relational properties among objects. The same object at the same time can be smaller than some and larger than

others. The child must be able to realize that in asymmetrical relations, each object must be simultaneously understood in the light of both direct and inverse relational operations (Flavell, 1963). In other words, one must be able to perceive that every object has more than one ralationship with others. The ability to coordinate information from several sources and to make the system totally surveyable at any given point in time is a characteristic of simultaneous processing.

Simultaneous processing also assumes an important role in the acquisition of the conservation concept. In achieving the conservation concept, the child must recognize that the transformation changes the objects on two dimensions simultaneously and should be able to coordinate the dimensions such that variations in one are simultaneously ordered with variations in another (Silverman & Rose, 1982). The characteristics of basic thought processes such as decentering, reversibility, and compensation, which are involved in conservation performance are congruent with that of simultaneous processing.

Similarly, in achieving class inclusion concept, the relation between all and some must be grasped; the child should be able to think of the parts as discrete from the whole, and simultaneously think of the whole itself (Piaget, 1954). The understanding of the part-whole relations is essential for the development of class inclusion concept. Simultaneous processing is thus involved in class inclusion

performance as the child is engaged in a process of discerning classes from two points of view: one as classes in their own right, and the second as members of a superordinate class.

While simultaneous processing is closely linked with concrete operational skills, successive processing may sometimes become a liability. A successive processor, like a preoperational subject, tends to link actions or perceptual states in a step-wise or sequential fashion without displaying a simultaneous and all-encompassing purview of all the perceptual states.

One might argue that the development of simultaneous processing is an age-related phenomenon as is performance on Piagetian tasks. Since many of the subjects who were labeled as high-simultaneous processors on the basis of the double-median split analysis were from the upper age-bracket, they performed better on Piagetian tasks. The argument would probably be incorrect because in the case of successive processing, many high successive processors also came from the upper age-bracket. But successive processing, unlike simultaneous, was not associated with performance on Piagetian tasks. As the results show, both coding processes appear to improve as chronological age increases, but simultaneous processing alone is related to performance on concrete operational tasks.

Summary: In summary, the results indicated that simultaneous processing provides an appropriate strategy for solving

concrete operational tasks, while successive processing may in some instances become a liability. However, it is not clear how simultaneous processing is specifically used at the time of solving Piagetian tasks; there remains a need to study the exact relationship between the two. The importance of the present study lies in its attempt to understand which process underlies concrete operational performance; but a different sort of experiment should be designed to specify how simultaneous processing is utilized.

Relationship of Simultaneous-Successive Processing with Clustering, Serial Short-Term Recall, and Syllogistic Reasoning

The raw scores of two simultaneous and two successive tests of 125 subjects, who took the the Clustering in Free Recall, Serial Short-Term Recall, and the Syllogistic Reasoning Tests were submitted to a principal components analysis. The varimax loadings on the two factors were used to calculate the simultaneous and successive factor scores for each subject. A double median split procedure similar to that described in the previous section was followed for dividing subjects into four groups. This division of the subjects into four groups was carried out on the entire sample and also on the nonschooled sample separately. The means and the standard deviations of these four groups are presented in Table 28, and the results of the two way fixed-model analyses of variance are reported in Table 29.

Because the medians of the groups are sample-dependent statistics, one could have used the random-model analyses of variance to analyze the data. Since, the interaction terms were very low for all the analyses, the results would have been essentially similar to those reported in Table 29.

As may be seen in Table 29, neither the main effects of simultaneous and successive processing nor their interaction was significant for the clustering index obtained before the verbal cuing was done. However, both the processes facilititated clustering in the recall output following verbal cuing by the experimenter. As may be recalled, the fourth trial in the clustering test was verbally cued at both presentation and recall. The subjects were told the four category labels at the time of presentation, and were also reminded at the time of recall. The results obtained with the entire sample demonstrated significant effects of simultaneous and successive processing for the clustering index obtained in the fourth trial. For the nonschooled sample the interaction between both the processes were significant.

The results indicate that neither simultaneous nor successive processing was involved in subjects' spontaneous clustering of the recall output. But those subjects with a preference for either mode of processing could effectively utilize the experimenter's cue towards increasing clustering in their recall output. The involvement of simultaneous and successive processes in clustering as a result of verbal

Table 28

Means and SDs of Four Groups on Clustering,
Serial Short-Term Recall and Syllogistic Reasoning Tests

Groups		Clustering (3rd Trial)	Clustering (4th Trial)	Serial S-T Recall	Syllogistic Reasoning
		Entire Sample (N = 125)			
High Simul-High Succ (N = 33)	Mean	.37	.49	7.31	11.64
	SD	.14	.16	1.51	1.54
High Simul-Low Succ (N = 29)	Mean	.37	.42	6.72	11.21
	SD	.13	.13	1.41	2.01
Low Simul-High Succ (N = 30)	Mean	.37	.42	6.73	10.63
	SD	.14	.15	1.93	1.77
Low Simul-Low Succ (N = 33)	Mean	.41	.36	6.39	10.48
	SD	.13	.14	1.39	1.79
		Nonschooled Groups (N =75)			
High Simul-High Succ (N = 19)	Mean	.36	.40	7.05	11.57
	SD	.14	.14	1.58	1.80
High Simul-Low Succ (N = 19)	Mean	.39	.43	7.10	11.10
	SD	.12	.14	.94	1.45
Low Simul-High Succ (N = 19)	Mean	.40	.41	6.42	10.41
	SD	.15	.16	2.06	1.58
Low Simul-Low Succ (N = 18)	Mean	.37	.31	5.72	10.48
	SD	.11	.14	1.36	1.95

Table 29

A Summary of 'F' Statistics Showing the Effects of Simultaneous and Successive Processing on Clustering, Serial Short-Term Recall and Syllogistic Reasoning

Source	df	Clustering (3rd Trial)	Clustering (4th Trial)	Serial S-T Recall	Syllogistic Reasoning
		Entire Sample (N = 125)			
Simul. (A)	1	.66	5.64*	2.56	7.35**
Succ. (B)	1	1.04	4.76**	2.66	.82
A X B	1	.21	.08	.18	.19
Error Var.	121				
		Nonschooled Groups (N = 75)			
Simul. (A)	1	.13	2.45	7.99**	6.82*
Succ. (B)	1	.01	.79	.82	.35
A X B	1	1.49	3.99*	1.11	.63
Error Var.	71				

cuing was further supported by a significant interaction of both the processes for the nonschooled sample.

The serial short-term recall measure showed an inconsistent relationship with the two coding processes. The results obtained from the entire sample indicated no significant effects of simultaneous and successive processing or their interaction. However, in the nonschooled sample, only the main effect of simultaneous processing was significant, thus suggesting that the high simultaneous processors were better in their overall recall of picture locations in comparison to the low simultaneous processors. It may be seen from Table 29 that the 'F' values associated with the main effects of simultaneous and successive processing for the entire sample reached significance at .12 level, thus indicating that both the coding processes were involved to a certain extent in serial short-term recall of locations. On the other hand, in the nonschooled sample, the simultaneous processing was responsible for the performance on the serial short-term recall task. This might have been due to the fact the nonschooled children were very poorer in successive processing and, therefore, could not effectively utilize successive processing in a task, that can be approached either in a simultaneous or in a successive fashion. However, this inconsistency in the pattern of results does not permit a precise understanding of the relationships between coding processes and serial short-term recall of locations.

The results for the Syllogistic Reasoning Test were clearcut. For the entire group as well as for the nonschooled subjects, only the main effects of simultaneous processing was significant, thus suggesting its importance for solving verbal logical problems. The manner in which syllogistic reasoning tasks are solved seems to be compatible with the characteristics of simultaneous processing. In solving verbal-logical reasoning tasks, the subject encodes the linguistic information of the problem into a mental representation, which is then followed by an attempt to draw inferences from this representation (Falmagne, 1975). Thus, the first stage involves the encoding of the problem premises, and the second one consists of applying a mental operation on the encoded information (Evans, 1972). For a correct solution, the encoding of the linguistic information involves an internalization of the fact that the premises belong together, not as separate entities which are independent of each other. The subject is required to examine not only the premises, but also the relationships that exist among them in order to draw a correct inference. Hence, the syllogistic reasoning task demands relational thinking which is also a characteristic of simultaneous processing. In view of the fact that simultaneous processing provides an appropriate strategy for solving syllogistic problems, simultaneous processors have an apparent advantage over those who prefer successive processing in solving verbal-logical problems.

The findings of the present study, however, did not support Bickersteth and Das's (1981) observation that both coding processes are essential for solving syllogisms. They had pointed out that although both coding processes may be used for solving syllogisms, preference for one process or another may be largely determined by the characteristics of the sample. The success rate of the present sample in syllogistic reasoning was higher compared to that of children used in their study. It might be argued that at an advanced level of operation, the subjects might have relied heavily on simultaneous processing for solving syllogisms.

Summary: In summary, it was demonstrated that neither simultaneous nor successive processing was involved in exhibiting spontaneous clustering. However, when the category names were made explicit, subjects with a preference for either mode of processing tended to show increased clustering in their recall output. Secondly, both coding processes showed an uncertain relationship with serial short-term recall of locations. Finally, the performance on the syllogistic reasoning task was to a large extent facilitated by simultaneous processing.

IV. STUDY TWO

A Rationale for the Study

This study proposed to investigate the effects of nonschooled literacy on the nature and pattern of coding and planning processes. In addition, the performance characteristics of literate and illiterate adults on tasks that tap some memory and problem solving skills were also examined.

The coding and planning processes for this study derive their connotations from the information-integration model of Das, Kirby and Jarman (1975, 1979). The reasons for adopting this approach for the study of cognition have been discussed earlier. Since elementary forms of reading and writing experiences are highy related to simultaneous and successive processing, it was of interest to examine the role of literacy in developing these processes. Would the literates be superior to illiterates in one kind of processing or another?

The differences between the developmental perspective and the practice perspective in terms of the claims they make for cognitive consequences of literacy have been discussed in the review of literature. Following arguments in favour of a developmental perspective (Greenfield, 1972; Olson, 1977 a,b), it can be claimed that written language is associated with improved logical competence and abstracting abilties which have widespread intellectual consequences. At least the exposure to alphabetic script and the school-based

written texts provides one of the important reasons explaining why schooled children perform better on cognitive tasks. Since literates are also exposed to the beneficial effects of written texts, would the same pattern of differences emerge in the comparison of literates and illiterates? Certain cognitive tasks which are shown to be sensitive to the effects of schooling were also included in the test battery. The tasks that were included in this study were Syllogistic Reasoning, Clustering in Free Recall and Serial Short-Term Recall of Locations. Each task measures a specific cognitive ability in its own way. These have been described in Study One.

In summary, the objectives of this study were:

1. To examine the influence of literacy training on the development of coding and planning processes within the theoretical framework of the information-integration model developed by Das, Kirby, and Jarman (1975, 1979).
2. To determine the role of literacy in developing certain cognitive skills as tapped by Syllogistic Reasoning, Clustering in Free Recall, and Serial Short-Term Recall of Locations Tests.

Major Hypotheses

Hypothesis 1

Literate adults are expected to be better in successive and simultaneous processing than illiterate adults, while no such differences are expected with regard to performance on 'planning' tasks.

Hypothesis 2

Scribner and Cole (1981) suggest that nonschooled literacy does not promote logical reasoning, abstracting, and generalizing abilities. It is expected that literates and illiterates in this study would not differ in their performance on tasks measuring skills related to verbal-logical reasoning, memory and retrieval strategies.

Sample

The sample consisted of 20 literate and 20 illiterate adults in the locality of Angul, India. Both adult groups came from the same villages and were homogeneous in terms of sharing the pattern of their community experience. The literates had undergone a 10-month period of literacy training in their respective villages.

Recently, the Ministry of Education and Social Welfare of India has undertaken the task of educating illiterate adults through a National Adult Education Programme, which has been implemented in different parts of India since 1978. The program aims at educating illiterate adults to read and write in their regional language. The teaching and learning conditions in literacy centers are not like a formal school setting. Attempts are made to make learning experiences relevant to the living and working conditions of people. Through literacy training, adults are taught a variety of skills including child-care, family planning, agriculture, and such other things which are of practical benefit in

their life situations.

The State Resource Center for Adult Education in Angul, Orissa has taken a project area consisting of 30 Adult Education Centers; 20 are exclusively for men and 7 are exclusively for women. The total population in the project area is approximately 12000 out of which approximately 5500 are illiterates. A portion of the illiterate population in this area attend these 30 resource centers. The main occupation of these people is land cultivation.

The sample for this study was drawn from five male Adult Education Centers in this locality. The mean age of the literate and illiterate groups were 19.25 and 22 years respectively. The literate subjects were able to read and write at a very elementary level, but their comprehension skill was very low.

Tests

All the literate and nonliterate adults were tested on the simultaneous-successive-planning battery. The Word Reading Test was given to the literate adults only. For the Figure Copying and Trail-Making tasks, the adult versions of the tests were used. These tests have been described in detail in Study One.

In addition, all the subjects were given the following three tests: Category Clustering in Free Recall, Serial Short-Term Recall of Locations, and Syllogistic Reasoning. These tests, their administration, and scoring procedures have been described in Study One. However, there were slight

changes in the test for Category Clustering in Free Recall. Instead of 16 cards, 20 cards with four categories of pictures were used.

Procedure

The procedure was essentially similar to that described in Study One. All the tests were administered individually, and in the order described in Study One. The subjects were tested in their respective villages in their native language, Oriya. They were provided with financial reinforcements (half of their daily wages) in order to obtain their cooperation for the testing.

Results and Discussion

This chapter has been organized into four sections. The first section deals with the simultaneous, successive and planning battery. The next three sections examine the performance of the adult literates and illiterates in Clustering in Free Recall, Serial Short-Term Recall of Locations, and Syllogistic Reasoning Tests. Attempts are made to relate the performance levels of the adults in these tests to those of the schooled and nonschooled children, which were described in Study One. A brief discussion of the findings is also presented in each section.

Simultaneous-Successive-Planning Battery

The means, standard deviations and the results of the analyses of variance comparing the performance of the literate and illiterate adults are presented in Table 30. The intercorrelations among the various cognitive variables

Table 30

Means, Standard Deviations and 'F' Statistics of Simultaneous, Successive and Planning Tasks for the Literates and Illiterates

Variables		Groups		
		Literates (N=20)	Illiterates (N=20)	F
Figure Copying	Mean	16.70	13.90	4.57*
	SD	3.54	4.48	
Memory for Designs	Mean	31.05	23.60	19.42**
	SD	5.34	4.86	
Digit Span	Mean	4.40	4.10	3.23
	SD	.49	.54	
Auditory Serial Recall	Mean	29.95	24.40	5.83*
	SD	7.10	7.07	
Visual Search	Mean	5.24	5.75	<1
	SD	2.10	1.70	
Color Naming	Mean	74.80	83.35	<1
	SD	28.45	28.15	
Trail Making (Cards: Form A)	Mean	5.95	6.61	3.71
	SD	1.18	.91	
Trail Making (Cards: Form B)	Mean	7.42	7.96	5.45*
	SD	.76	.66	
Trail Making (Number: Form A)	Mean	8.00		
	SD	.77		
Trail Making (Number: Form B)	Mean	8.84		
	SD	1.94		
Word Reading	Mean	43.15		
	SD	18.42		

* $p < .05$
** $p < .01$

and the factor structure of the simultaneous, successive and planning battery are presented in Tables 31, and 32 respectively.

The mean Word Reading scores of the literate adults (mean=43.15) is comparable to that of the Grade 2 children (mean=44.86). The analyses of variance revealed that for both the simultaneous tests (Figure Copying, Memory For Designs), the literate adults were better than their illiterate counterparts. The results indicated a significant difference between the literates and illiterates in one of the successive tasks, Auditory Serial Recall, in favor of the former. For Color Naming, Visual Search, and Form A of Trail Making (cards), no significant differences were observed between the two groups.

The correlations presented in Table 31 were submitted to a principal components analysis with the Color Naming Test excluded from the battery. The factors having eigen values greater than 1 were rotated to the varimax criterion. The varimax loadings of these tests are reported in Table 32. The second and the third factors corresponded closely to the pattern established in previous research (Das, Kirby, & Jarman, 1975, 1979), and were, thus, labeled simultaneous and successive factors respectively. Although the number of subjects (N = 40) was small, it was gratifying to see that the factor analysis confirmed the previous results. The first factor which was defined by the Visual Search, and the two forms of the Trail Making Test conforms closely to a

Table 31

Intercorrelations of Simultaneous-Successive-Planning Battery and Color Naming Test for the Adult Sample (N = 40)

Variables	FC	MFD	DS	ASR	CN	VS	TMA	TMB
Figure Copying (FC)								
Memory For Designs (MFD)	.600							
Digit Span (DS)	.087	.056						
Auditory Serial Recall) (ASR)	.057	-.057	.418					
Color Naming (CN)	.008	-.092	-.223	-.054				
Visual Search (VS)	-.112	-.276	-.246	.133	.026			
Trail Making Cards: A (TMA)	-.025	-.280	-.187	-.033	.412	.349		
Trail Making Cards: B (TMB)	-.326	-.232	-.198	-.123	.261	.277	.713	

Table 32

Principal Components Analysis with Varimax Rotation of Simultaneous-Successive-Planning Battery

Variables	Factors I	II	III	h2
Figure Copying	-.032	.920	.102	.857
Memory For Designs	-.255	.841	-.077	.778
Digit Span	-.245	.026	.770	.654
Auditory Serial Recall	.107	.003	.886	.797
Visual Search	.647	-.133	.075	.442
Trail Making (Cards: Form A)	.898	-.002	-.082	.812
Trail Making (Cards: Form B)	.784	-.209	-.203	.700
% of Total Variance	28.24	23.07	20.70	

planning factor established in previous research (Ashman, 1978). However, the naming of this factor as 'planning' is to some extent complicated by the fact that the Color Naming Test, when it was included in the test battery, had a high loading on this factor.

In a previous research with Grade 8 Canadian children, Ashman (1978) was able to demonstrate the emergence of three independent factors called simultaneous, successive, and planning. The planning factor in Ashman's study was mainly defined by the Visual Search, and Trail Making Tests. The 'planning' factor in this study was not completely independent of the Color Naming Test, which has been regarded as defining a 'speed' factor in previous research (Das, Kirby, & Jarman, 1975; Kirby, 1976; Jarman, 1975). But, in order for the Color Naming Test to be uncorrelated with 'planning', the naming of the colors needs to be spontaneous and automatic. This criterion was not met by the sample in this study. In addition, the educational experience of this sample was not comparable to that of Ashman's. Since planning is a higher form of cognitive activity, its emergence as a separate independent entity from a lower level skill such as color naming would only be possible with some amount of educational experience.

The emergence of two independent coding processes known as simultaneous and successive syntheses was clearcut. Multivariate analyses of variance was employed to analyze the performance of the literate and illiterate adults on the

two simultaneous and the two succesive tasks. The results revealed that the adult literates were superior to illiterates in both simultaneous ($F_{2,37}=9.49$, $p<.001$), and successive processing ($F_{2,37}=3.33$, $p<.05$).

Both adult groups came from the same villages, and homogeneous sociodemographic background, and were also homogeneous in terms of sharing the patterns of community experience. Thus, the superiority of the literates could be to a great extent attributed to their 10-month literacy training. The literacy training involved reading and writing experiences at a very elementary level. The skills involved in writing letters involve visual analysis of letter patterns and the subsequent reproduction of those patterns. These skills form the essential characteristics of the simultaneous coding process. Following the initial acquisition of printing and recognizing alphabets, the letters are arranged successively to form words, and the word elements are put in a sequence to construct sentences. The reader at this stage is engaged in a successive mode of thinking, which develops gradually through extended practice of word and sentence construction. As a result, elementary forms of reading and writing manifest themselves in the form of an improvement in simultaneous and successive coding processes.

It would be instructive to compare the performance of the literate and the illiterate adults with that of schooled and nonschooled children in Study One. The comparison would

further specify the role of age and educational experience on the development of the two coding processes. In terms of the reading and writing skill and the period of literacy training, the literates were comaparable to the 6-8 year old children (Grade 2). As may be recalled, the literate adults and Grade 2 children were reading words at an equal level of competence as found in the Word Reading Test.

The means of the children and adult groups on simultaneous and successive tests are plotted in Figure 4. For both the successive tasks, the performance of the literate adults was comparable to that of the 6-8 year old schooled children (Grade 2). The mean scores of the 20-year-old literate adults and 6-8 year old schooled children were 4.10, and 4.36 for Digit Span, and 29.95 and 28.60 for the Auditory Serial Recall respectively. The 22 year old illiterates were similar to the 10-12 year old nonschooled children, but both these groups were inferior to Grade 2 children. The results indicate the impact of one year of reading and writing experiences on successive processing, which otherwise does not develop when children do not attend school.

On the other hand, the picture with simultaneous processing is clearly different. In the Figure Copying Test, the illiterates (mean=13.90) perform at a level comparable to that of 10-12 year old schooled (Grade 5) children (mean=13.86), and the literates still do better (mean=16.70). For the Memory for Designs Test, the

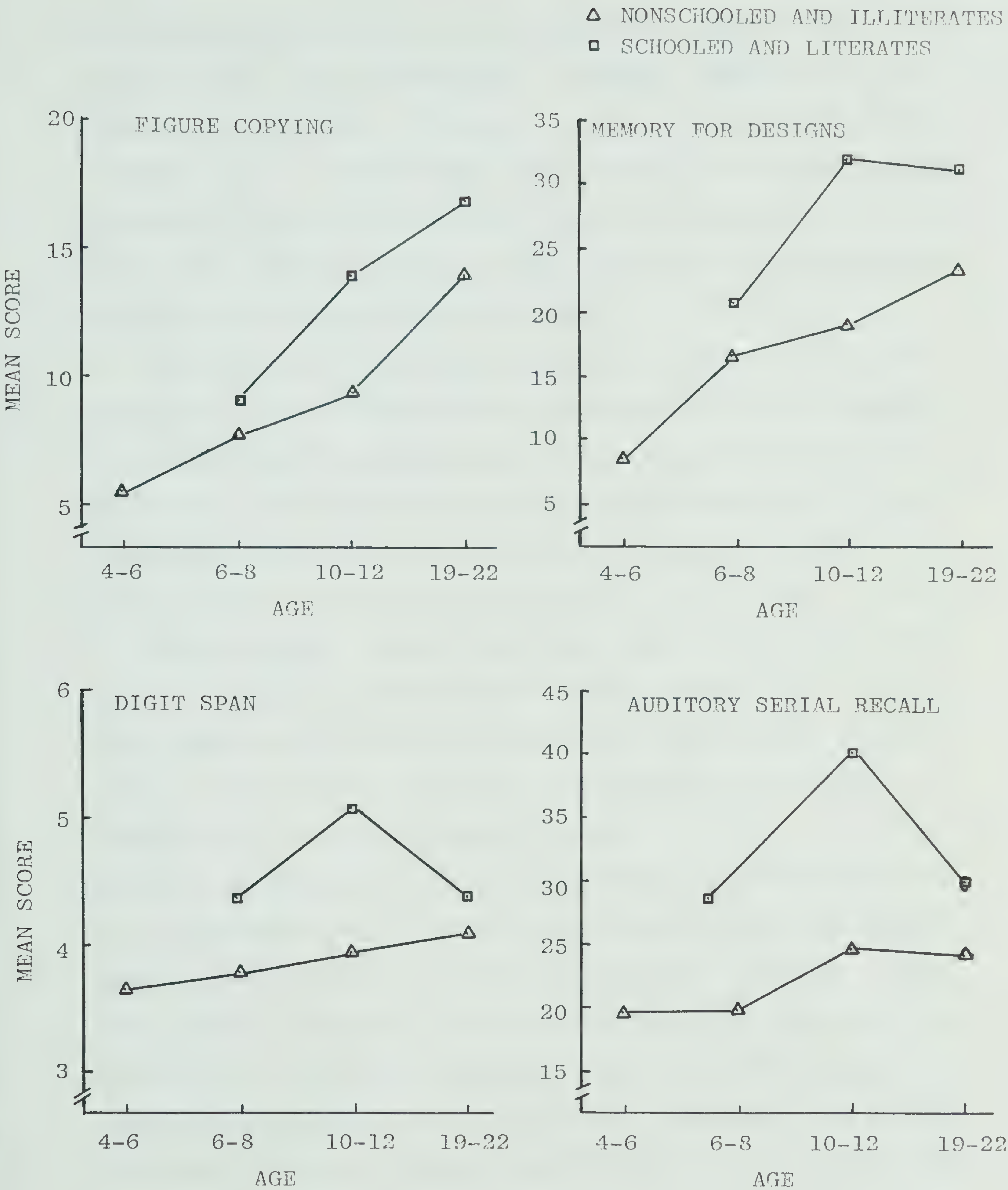

Figure 4. Mean scores of children and adult groups on simultaneous (Figure Copying and Memory for Designs) and Successive (Digit Span and Auditory Serial Recall) Tasks.

performance level of the literate adults (mean=31.05), and 10-12 year old schooled children (mean=32.36) are comparable, with the illiterate adults (mean=23.60) being clearly at a disadvantage. But unlike that observed with successive tests, both the adult groups are superior to 6-8 year old schooled (Grade 2) and 10-12 year old nonschooled children in simultaneous processing.

Although, both coding processes seem to develop as a function of age and educational experience, the development of successive processing appears to be largely determined by schooling. The reading and writing experiences at a very elementary level greatly enhance successive processing. This speculation is further supported by the correlation (r=.36) of Word Reading score with Digit Span, which is a marker test of successive processing. In this regard the findings are consistent with the view of earlier researchers (Cummins & Das, 1978) that successive processing is related to reading skills at an elementary level.

Summary: In summary, it was demonstrated that the emergence of simultaneous and successive syntheses as two independent coding processes was clear for this sample, whereas there was partial support for the exsistence of a factor called 'planning'. Secondly, literacy experience was found to favorably influence the development of both the coding processes. Finally, although age and educational experience contributed towards the development of both forms of syntheses, the role of education on successive mode of

thinking was relatively more important; this finding is consistent with the results obtained in Study One.

Clustering in Free Recall

Bousfield's (1953) Ratio of Repetition (RR) index as a measure of clustering was used for scoring the recall protocols. The rationale for using RR index has been given in Study One. The mean clustering scores of the literate and illiterate adults before and after verbal cuing are reported in Table 33. A 2 (literates vs. illiterates) X 2 (repeated measures before and after verbal cuing) analysis of variance was employed to analyze the data. The summary results of this analysis are presented in Table 34.

As may be seen from Table 34, neither the group or verbal cuing effect nor their interaction was significant. The results support the view that literates were not different from illiterates in demonstrating spontaneous clustering, and that clustering did not improve in either group as a result of verbal cuing. The literacy training did not significantly improve subjects' ability to utilize experimenter's cues for making use of the classification scheme selected by the experimenter. In this respect, the findings are consistent with those reported by Cole, Gay, Glick, and Sharp (1971) on Kepple subjects in Liberia.

Summary: Although, the overall clustering of the adults was superior to that of schooled and nonschooled groups used in Study One, the adults, like nonschooled children, could not

Table 33

Group Means and Standard Deviations of Clustering Scores Before and After Verbal Cuing (N = 20 in each group)

Groups	Before Verbal Cuing (3rd Trial)		After Verbal Cuing (4th Trial)	
	Mean	SD	Mean	SD
Literates	.52	.13	.58	.17
Illiterates	.50	.12	.51	.16

Table 34

Summary of Analysis of Variance of Clustering in Free Recall

Source	df	MS	F
Between Subjects	39		
Group (A)	1	.041	1.39
Subj w grp	38	.029	
Within Subjects	40		
Trials (B)	1	.020	1.63
A X B	1	.013	1.04
B X Subj w grs	38	.012	

effectively utilize the verbal cues to improve semantic organization in their recall. The results suggest that at least 4 to 5 years of schooling experience is required to follow the category names provided by the experimenter for enhancing clustering in the recall output.

Serial Short-Term Recall of Locations

The means and standard deviations of the literate and illiterate adults for the total recall, as well as for the primacy, middle-positions, and recency recall are presented in Table 35. The mean recency recall was higher in comparison to the primacy, and the middle-positions recall, and in this sense, the data conform closely to the pattern established in previous research (Wagner, 1974, 1978).

The analysis of variance revealed a significant group difference in the overall and middle-positions recall in favor of the literate adults (Table 35). Of special interest to the study were the group differences in primacy and recency recall, which were not found to be significant. The primacy and the recency recall have been regarded as measures of control processes and short-term store in memory respectively (Atkinson & Shiffrin, 1968; Wagner, 1978). In view of an absence of group differences in these two measures, it may be concluded that a 10-month period of elementary literacy training does not significantly influence either the structural or the control processes in memory such as rehearsal.

Table 35

Group Means (proportion correct) and Standard Deviations of Serial Short-Term Recall
(N = 20 in each group)

		Groups		F
		Literates	Illiterates	
Total Recall	Mean	.57	.47	4.34*
	SD	.17	.13	
Primacy	Mean	.63	.55	.71
	SD	.31	.25	
Middle-Positions	Mean	.42	.29	4.21*
	SD	.21	.17	
Recency	Mean	.74	.66	1.02
	SD	.27	.19	

* $p < .05$

The primacy effect is closely linked to verbally mediated rehearsal strategies (Flavell, 1970; Hagen, 1971), which obviously does not develop as a result of reading and writing experiences at an elementary level. Both primacy and recency effects were observed by Wagner (1978) in Morocco as a function of at least 6 years of formal schooling experience. In light of this evidence, one would not expect a significant improvement in these two measures in favor of the literate adults.

However, the data did not support Wagner's view that "control processes appeared to be a function of age, but only when coupled with schooling" (p.1). Wagner made this observation on the basis of the poor performance of nonschooled adult groups in comparison to younger groups of schooled children in primacy recall. This statement may not be universally applicable to all cultures. In the present study, adult literates as well as illiterates demonstrated a slightly higher primacy recall compared to 10-12 year old schooled children, who had four years of formal educational experience. The data, therefore, support the view that age alone can be a potential variable in influencing primacy recall. Since, rehearsal strategies are closely linked to primacy recall, it is suggested that such strategies can develop as a function of age in certain cultures. The contribution of the specific cultural experiences is further supported by the fact that the present literate sample with only a 10-month period of literacy training were similar in

their overall recall performance to a comparable age group of Moroccan adults with 11 years of formal schooling experience.

Summary: In summary, a 10-month period of literacy training did not significantly improve the spontaneous application of the remembering strategies such as rehearsal, and in this regard, the findings were consistent with that of previous researches. It was demonstrated that recency recall, which is a measure of primary memory remained relatively unaffected by age. On the other hand, some degree of improvement in primacy recall occurred as a function of age only, even when it was not coupled with formal schooling experience.

Syllogistic Reasoning

The means, standard deviations and the 'F' values associated with group differences for the total as well as seven different types of syllogisms are presented in Table 36. No significant differences were observed between the literate and the illiterate adults in any category or for the total number of syllogisms solved. The results do not imply any significant effect of literacy training on subjects' ability to solve verbal-logical problems. In this respect, the findings are not consistent with those of Luria (1971), who observed a marked improvement in syllogistic reasoning performance as a result of minimal literacy training.

Table 36

Group Means, Standard Deviations and 'F' Values
for Different Types of Syllogisms
(N = 20 in each group)

Syllogisms		Groups		
		Literates	Illiterates	F
Total	Mean	11.05	11.30	.20
	SD	1.93	1.59	
Familiar	Mean	1.80	1.80	.00
	SD	.41	.41	
Unfamiliar	Mean	1.80	1.85	.17
	SD	.41	.37	
Artificial	Mean	1.85	1.90	.11
	SD	.49	.45	
Contrary to experience	Mean	1.40	1.25	.42
	SD	.75	.72	
Conjunctive	Mean	1.55	1.65	.40
	SD	.51	.49	
Disjunctive	Mean	1.85	1.75	.60
	SD	.37	.44	
Implicative	Mean	.80	1.10	1.37
	SD	.83	.79	

The data also did not support the view that 'preliterates' or 'traditional' people are poorer in logical processes as manifested by their inability to solve verbal-logical problems. This view was espoused by previous investigators on the basis of a number of research carried out in African societies (Cole, Gay, Glick, & Sharp, 1971; Scribner, 1977) , in Mexico (Sharp, Cole, & Lave, 1979), and in Central Asia (Luria, 1976). They suggested that schooling is an important variable positively influencing verbal-logical processes, and that at least three to four years of formal educational experience is necessary for solving syllogistic problems. However, in the present sample, both literate and illiterate adults were performing at a level of competence that is comparable to that of Grade 4-6 Mexican or Liberian students (Sharp, Cole, & Lave, 1979; Cole, Gay, Glick, & Sharp, 1971). Both the groups were able to solve on the average 11 out of 14 problems with a mean success rate of 80%, which is slightly higher than the 75% success rate of Grade 4-6 children of Canada and Sierra leone (Bickersteth, 1981).

On the basis of this evidence, it appears that the performance characteristics revealed by Russian peasants, or illiterate adults in African societies may not be universally applicable to all cultures. On the other hand, future research should attempt to understand the specific cultural experiences that contribute towards improved performance of the present sample on verbal-logical tasks.

One proposal would be to examine the quantitative and qualitative aspects of verbal interactions that the adults in Indian 'traditional' communities engage in, as a part of their daily routine life.

One might possibly argue that the problems used in the present study were relatively easy compared to those used by Sharp, Cole, and Lave (1979) in their Mexican research, and therefore, failed to discriminate the groups. It can be seen from Appendix I, that the nature and format of these items were very similar and in some cases identical to those used in previous investigations.

The performance level of the literate and illiterate adult groups was similar to that of 10-12 year old schooled (Grade 5) and nonschooled children. The data further suggest that in this culture, four years of formal educational experience did not significantly enhance the ability to solve verbal-logical problems. There was no prior knowledge of how these subjects would 'handle' syllogistic problems. Thus, the items were chosen so as to be similar to those used by other researchers for purposes of comparability of the findings. The findings of this study suggest that a relatively difficult set of items should be used in future research in order to investigate the influence of schooling and maturation on verbal-logical processes.

To what extent can performance on syllogistic reasoning tasks be taken as an evidence of logical reasoning? There is no evidence that the performance differences on syllogistic

problems is due to subjects' ability to reason logically, but rather it may be due to their willingness to accept syllogisms as self-contained hypothetical problems from which inferences can be drawn. If nonschooled and illiterate subjects can willingly accept the problem as a self-contained logical unit, they would be expected to perform as well as their schooled and literate counterparts.

Several documented responses from previous research (Luria, 1971; Scribner, 1977; Cole, Gay, Glick, & Sharp. 1971) suggest that some illiterate adults in those studies were unwilling to regard the syllogistic task as a hypothetical problem. Instead, they appeared to evaluate the problem contents on the basis of their personal normative knowledge, which in some cases led to the modification of the premises to be congruent with their past experiences. In some cases, the subjects refused to engage in a process of verbal-logical deduction, as the correct solution to the problems could not be reached on the basis of the subjects' knowledge of the world. For example, in response to a problem, "In the far north, all bears are white; Novaya Zemyla is in the far north; what colors are the bears there?", illiterate people refused to answer, as they were neither familiar with the place nor the bears. Similar patterns of responses to several syllogistic problems were also characteristic way of responding of the illiterate and nonschooled adults in Liberia, and Mexico. For some subjects in the present sample, their past experience dictated the

answers to some problems, but none of the subjects refused to answer a problem or brought in their past knowledge to an extent that would modify the problem contents.

All the subjects were asked to give justification for their answers. Because of the short nature of the verbal explanations, it was rather difficult to judge whether or not a subject was explicitly engaged in a verbal-logical deductive process in deriving the correct solution. Therefore, it was not possible to mark all the responses as either 'theoretic' or 'empiric', using the classification scheme of Scribner (1977). There were a few responses which could readily be judged as 'theoretic', but most of the responses did not conform clearly to this 'theoretic-empiric' dichotomy. The difficulties in distinguishing between a 'theoretic', and 'empiric' response have been discussed in the 'review of literature' section.

Since, verbal-logical performace seems to be regarded as a fundamental process of cognition (Luria, 1971), there is no reason to expect a significant difference in this basic cognitive skill as a result of a 10-month period of literacy training. On the other hand, the contribution of specific cultural experiences may seem to be important for the development of verbal-logical skill as cultures differ in the way they 'modify' or 'amplify' the basic processes of cognition. The findings of this study supported these two views.

Summary: In summary, it was demonstrated that one year of literacy training did not improve the ability to engage in a process of verbal-logical reasoning as indexed by performance on syllogistic reasoning problems. Secondly, the data did not support the view that the poorer performance of 'illiterates' on verbal-logical problems is a universal phenomenon.

V. GENERAL DISCUSSION

A General Summary

The research began with the objective of evaluating the course and rate of cognitive development as a function of schooling and literacy as separate experiences, within the cultural context of Orissa, a South Eastern province in India. The locale of the study was Angul, where it was possible to find schooled and nonschooled children and literate and illiterate adults from a relatively homogeneous sociodemographic background. There were no linguistic and cultural barriers between the subjects and the investigators, as the latter shared a part of the subjects' culture, customs, rituals, and conventions. The test materials and situations were made as familiar to the subjects as possible. In addition, unlike some previous research, the study adopted a process-oriented approach and attempted to study the cognitive consequences of schooling and literacy within the theoretical framework of the information-integration model proposed by Das et al., (1979). The tests used in the present study fell into three categories: (1) tasks related to the simultaneous-successive information processing model, (2) concrete operational tasks within the context of Piagetian theory, (3) tasks related to memory, retrieval strategies, and problem solving.

The preceeding sections were primarily concerned with the data and statistical analyses. Therefore, corresponding to each of the hypotheses stated previously, the salient

experimental findings are briefly reported.

Study One:

1. The performance on Piagetian concrete operational tasks improved as a function of age; neither the main effects of schooling nor its interaction with age was significant for any of the Piagetian tasks.
2. In accordance with the information-integration model of Das et al. (1979), simultaenous and successive syntheses emerged as two independently defined coding processes for both schooled and nonschooled groups. The emergence of a factor called 'planning' was partially substantiated only for the 10-12 year old schooled (Grade 5) children.
3. Unlike Piagetian concrete operational skills, simultaneous and successive processes improved as a function of both age and educational experience; schooling had greater impact on successive as compared to simultaneous processing.
4. Neither schooling nor age was associated with spontaneous clustering of the recall output. However, when the stimulus list was partially structured by providing the category names as cues for retrieval, recall output tended to show increased clustering as a function of both age and educational experience.
5. In a memory task, the recall of the items at the end of the list (recency recall) remained invariant with age or schooling experience, while the recall of the beginning

items in the list (primacy recall) improved slightly as a function of age , and not of schooling.

6. Responses to verbal-logical problems showed a significant developmental trend, but failed to register the influence of schooling.
7. Simultaneous processing was involved in solving Piagetian concrete operational tasks, while successive processing was shown to be a liability in some instances

All the findings reported above supported the previously stated hypotheses except those concerning the role of schooling on primacy recall and verbal-logical performance. Although, it was hypothesized that both age and schooling would improve primacy recall and responses to verbal-logical problems, these two measures were influenced by age and not by schooling.

The performance on verbal-logical problems appeared to be facilitated by simultaneous and not successive processing. Neither simultaneous nor successive processing was involved in exhibiting spontaneous clustering in the recall output. But when the category names were made explicit, the subjects with a preference for either mode of processing tended to show increased clustering in their recall output. The relationship of the two coding processes with the serial short-term recall performance was very uncertain.

Study Two:

1. Both simultaneous and successive processing improved as

a function of elementary forms of literacy experience.

2. No significant influence of literacy training was observed on clustering, primacy and recency recall, and verbal-logical performance.

The findings from Study Two were essentially in agreement with the hypotheses stated previously.

Effects of Schooling

The significant influence of schooling was only noticed on the two information-processing modes, and also on the effective utilization of the categorical information of a stimulus array, when it was partially structured for the subjects by providing category names explicitly. Neither the influence of schooling nor its interaction with age was significant for any of the concrete operational, memory, and problem solving tasks used in the present study. Therefore, the findings raise serious questions concerning the concept of generalized cognitive structures that are produced as a result of 2 to 5 years of formal educational experience. A similar observation was made by Stevenson et al. (1978) on the basis of their research in Peru, which was, of course, confined to examining the cognitive consequences of only one year of schooling.

As expected, the superiority of schooled over nonschooled children was quite clearly marked for both coding processes. Through successive years of formal schooling experience, the differences between the schooled and nonschooled groups became increasingly wider in favor of

the former. The correlational data suggested that the two coding processes became progressively differentiated as a function of educational experience. successive processing appeared to develop much faster in childen who attended school.

The pattern of improvement in simultaneous and successive processing can be explained as follows. In schools, children learn the alpahabet, and learn to write letters and words. The skills required for writing letters involve analyses of the letter patterns, and subsequent reproduction of these patterns. One important aspect of the letter-writing skill is the child's simultaneous grasp of the structural components of the letters, which through extended practice imparted in school improves gradually. A failure in this skill results in confusion, which is noticed, for example, in English language when a child confuses between the letters 'b' and 'd', or 'p' and 'q', or between the numbers '6' and '9'. Gradually the child learns to connect letters to form meaningful words, words to form sentences, and then uses sentènces to construct small paragraphs to embed a stream of thought in a temporal order. Thus, following the initial acquisition of printing and recognizing alphabets, the skill mostly in demand is decoding which requires successive processing (Cummins & Das, 1977). The skill involved in arranging word elements in a sequence to construct sentences is also characteristic of successive processing, which develops as a child is engaged

in school in an elaborate and extended practice of word and sentence construction (Das, Cummins, Kirby, & Jarman, 1979). At this stage, the child also acquires deliberate remembering devices, and begins to develop awareness of formal linguistic structure - an opportunity which is relatively lacking in the nonschooled child's environment. So successive processing develops much faster in schooled than in nonschooled children. Beyond the initial stage of reading, as the child becomes aware of the semantic as well as the syntactic aspects of sentences, and as comprehension is increasingly demanded of the child, relational analysis or simultaneous processing assumes an increasingly important role (Kirby & Das, 1978). Thus the development of simultaneous processing skills is facilitated by schooling as well.

As mentioned earlier, the quality of teaching-learning conditions in the 14 schools sampled in this study were very poor. Rote learning as the technique of of teaching and mastering the contents of the curriculum was followed tenaciously by both teachers and pupils. The child's role in the learning process was one of passivity and unquestionable acceptance of the teachers' ideas, which left little flexibility for the transformation of the facts being taught. Neither the curriculum nor the teaching process made any provision for students to auto-regulate their experiences, to evaluate the utility of the learned material, and to construct a knowledge-base through

empirical observation, which according to Piagetian theory are crucial for the development of concrete operational skills. Therefore, the schools failed to develop qualitatively distinct intellectual capabilities, which can be applied to solve a variety of intellectual tasks in a variety of content domains. It is therefore, suggested that future studies should refrain from studying the effects of schooling as a 'packaged' variable. Rather attempts should be made to relate the teaching-learning processes adopted in schools to performance on various intellectual tasks, as has been done in this study. In addition, minimum levels of educational experience necessary for the emergence of various forms of cognitive skills should also be studied.

One of the intriguing findings of the present study was the lack of schooling's influence on syllogistic reasoning task, where the problem contents are more hypothetical and cannot be solved with recourse to real-world knowledge. Previous studies (Cole et al., 1971; Luria, 1976; Sharp et al., 1979) had shown that even low levels of education influence performance on this task. But the findings of the present study did not support the views of previous researchers. On the contary, both schooled and nonschooled children were operating at a level that was higher than that of the comparable age groups of children used in previous studies. Thus it is suggested that poorer performance of nonschooled subjects on verbal-logical tasks is not uniform across all cultures. In view of this, future research should

focus on what possible experiential variable is likely to account for the performance level of the present nonschooled sample. One important area of investigation would be to examine the level and quality of verbal interactions that the children and adults in this society engage in as a part of their daily routine life. At the same time it is also suggested that a relatively difficult set of syllogisms, possibly in the format of classical syllogisms (e.g., All men are mortal; all kings are men, are all kings mortal?) should be used to examine the generality of the present findings. The present data, however, supported the idea of a between-culture variation in syllogistic reasoning performance, which follows from Luria's (1976) conception that processes in cognition are to a large extent shaped by socio-historical experiences.

Some researchers argue that it is not schooling, per se, but it is the quality of schooling which is important for increased performance on intellectual tasks. If comparisons are made between nonschooled children, and children in schools with improved standards of instruction, curriculum and educational faclities, a larger effect of education is, of course, expected. However, as the schools vary in quality of teaching-learning conditions, so do the sociodemographic characteristics of children who reach these institutions. Hence, it seems that the effect of better quality schooling would be confounded with many other factors that covary with it. The interpretation of the

observed relation between the quality of schooling and the cognitive competence, then needs to be made in the context of covarying factors extrinsic to schooling. As far as this research is concerned, schooling of even poor quality, which is the only type of schooling available in remote rural areas in this part of India, seems to accelerate two basic cognitive functions. These benefits of schooling are over and above those resulting through maturation and experiences available in the children's milieu. The acquisition of concrete operational thought however, does not seem to profit from schooling.

Effects of Age

As predicted, and consistent with Piagetian theory, significant effects of age were obtained for all Piagetian tasks. No significant interaction of age and schooling was obtained for for any of the concrete operational skills. Considering the four nonverbal forms of Piagetian tasks, the order in which various concrete operational skills emerged was as follows: conservation of mass, transitivity, conservation of length and class inclusion.

The coding processes improved as a function of age, but the developmental change in successive processing was much slower compared to that of simultaneous processing. Both in schooled and nonschooled samples, considered separately, older children performed at a significantly higher level compared to younger children.

A significant developmental trend was noticed in syllogistic reasoning and primacy recall, as well as in the clustering index obtained after verbal cuing. There were no age-related changes in spontaneous clustering, recency recall, and a general memory proficiency, as indicated by overall recall measure in serial short-term recall of locations.

The overall findings with respect to age-related changes in cognitive skills indicate that the tasks used in the present study were developmentally sensitive. Unlike the findings of the prior studies, it was shown that age , even in the absence of schooling, might account for improved performance on memory and verbal-logical tasks, which tap some basic and fundamental aspects of cognition. There must be something in the culture, which is most likely to account for this outcome, and should be the subject of investigation in future research.

Comparing the Cognitive Consequences of Schooling and Literacy

As discussed earlier, one of the important reasons as to why schooled children outperform their nonschooled counterparts in the first few years of schooling is due to the former's exposure to the beneficial effects of the printed text and written form of language. Therefore, two separate studies were designed to examine if the cognitive changes associated with school education would be observed as a consequence of nonschooled literacy experiences.

Several claims have been made in the past with regard to how literacy produces and promotes context-independent thinking, abstract, and logical reasoning that are characteristics of higher order forms of cognition. Following this line of reasoning, which has been labeled by Scribner and Cole (1981) as a 'developmental persepctive', one would expect that higher order cognitive processes would develop as a result of either school-based or nonschooled literacy experiences. In the present research, neither schooling nor literacy was associated with any improved forms of memory and logical reasoning.

Scribner and Cole's research on Vai literacy indicated several localized literacy-specific effects on some task-related skills. While these researchers admitted a generalized cognitive effect as a result of schooling experience, they suggested that such kinds of changes in cognitive operations may not occur simply as a result of nonschooled literacy. The present research supported their contentions with regard to cognitive consequences of literacy exaperiences, but not with respect to that of schooling. Literacy experience, within the context of the present study, was not associated with any generalized cognitive operations, as would be manifested in higher levels of performance on memory and problem solving tasks. The effects of schooling and literacy were essentially similar in that neither of the two promoted intellectual capabilities resembling higher order forms of thinking.

The agreement between the results of both the studies was substantial in that both schooling and literacy experiences were important for the development of simultaneous and successive processing. Both the coding processes appeared to improve as a function of literacy or schooling. An explanation in terms of how elementary forms of reading and writing experiences improve simultaneous and successive processing has been given earlier in this section.

As may be recalled, the literate adults went through a 10-month period of literacy training. As a result of this, they were able to write the alphabets, and read their text books, but their comprehension was at a low level. Therefore, it was not expected that they would outperform their illiterate counterparts on tasks that give indications about generalized cognitive mechanisms. The results confirmed the previously stated hypothesis. The present research failed to extend support for Luria's observation that 6-12 months of literacy training can bring some important changes in solving syllogisms. Furthermore, it should be noted that both literate and illiterate adult groups in the present sample were performing at a relatively more competent level in the syllogistic reasoning task, compared to their counterparts used in previous studies. In view of this, future research may look for what experiential variables, besides literacy are most likely to account for the findings of the present as well as previous studies.

To summarize, the literacy training in Oriya, the native language of the subjects, did not produce any generalized cognitive effects. However, this outcome should only be interpreted within the limits of the present research, as the level of literacy experience investigated was very minimal. Future research should focus on the cognitive effects of advanced forms of literacy. On the basis of the present results, it is difficult to speculate how advanced literacy practices would influence general cognitive skills.

Simultaneous-Successive Factor Structure

The previous studies (cited in Das et al., 1979) within the framework of the simultaneous-successive information-integration model tested schooled children only. Until the present study, it had remained unclear whether the independence of two coding processes was a function of schooling, or it followed the natural course of human cognitive development. In the present study, factors identifiable as simultaneous and successive coding processes emerged for both schooled and nonschooled samples. Thus, the present findings clarified and extended the basic tenets of this model beyond populations on which the previous studies were based.

The involvement of simultaneous processing in solving concrete operational and syllogistic reasoning tasks carries an important implication for the simultaneous-successive model. Although, simultaneous processing is quasi-spatial in

nature, and has so far been assessed by tasks that are purely nonverbal in form, its involvement in solving verbal-logical problems and verbal form of transitivity suggests that simultaneous processing underlies the competence in both verbal and nonverbal domains of human cognition. The model not only extends beyond a simplistic notion of verbal-nonverbal dichotomy in human cognitive development, but also permits an understanding of which processes are involved in solving various intellectual tasks, and therefore, provides an alternative theoretical framework in the field of individual difference research.

The findings of the present study were consistent with those observed by Mwamwenda (1981), who used the Raven's Progressive Matrices and Figure Copying to measure simultaneous processing. In the present study simultaneous processing was indicated by Figure Copying and Memory for Designs. In spite of this, the agreement between the results of the two studies was substantial. The characteristics of the concrete operational processes such as decentering, reversibility, and compensation are congruent with that of simultaneous processing. Similarly in solving syllogistic reasoning problems, the subject uses simultaneous processing to perceive the relationships that exist among the premises in order to draw a correct inference.

In spite of the relationship of simultaneous processing with concrete operations, it remains unclear how this coding process is specifically used by children while solving

Piagetian tasks. There remains a need to further specify the relationships between the two coding processes and the concrete operational skills. A different sort of experiment, perhaps in the form of experimentally inducing simultaneous processing should be attempted to see if any improvement occurs in solving concrete operational tasks.

Suggestions for Future Research

As the results were presented and discussed, a few suggestions were made with regard to possible future research directions in the area of schooling and cognition. Here an attempt is made to summarize them in order to project an integrated picture for the reader as well as to include some additional suggestions, which could not be presented, while evaluating the results within the context of some specific findings.

In the area of schooling and cognition, the research up to date has been mostly correlational in nature. Interpretations have been made in terms of an apparent cause-and-effect relationship with schooling as the independent variable and task performance as dependent variable. This has been followed by speculations concerning schooling's influence on cognition on a post-hoc basis. The outcome of this line of research has been definitely helpful in providing the first important steps for future investigators. Considering the special problems of nonreplicability of cross-cultural studies, it is suggested that data should be obtained from a wide variety of cultural

settings and populations in order to test the generality of findings obtained from a few studies. But a predominant preoccupation with massive data-gathering projects would not advance our understanding of how schooling brings about cognitive changes.

There should be more process-oriented investigations, where it would be possible to examine which processes are developing as a function of formal education, and are associated with improved task performance. The simultaneous-successive model adopted in the present study provides one such information-processing analysis of the effects of schooling, and can be profitably utilized in future studies.

Mostly, previous studies had followed a cross-sectional design to examine the influence of schooling. It is suggested that a mixture of cross-sectional and longitudinal designs, i.e., cross-sequential design may be followed by future investigators.

As has been mentioned earlier, factors that are extrinsic to but covary with schooling should be given due attention, while considering the effects of schooling. Future research should examine the influence of schooling both in isolation and combination with that of the covarying factors such as SES, sex, caste, urban-rural environment etc. In a developing country like India, these variables are highly correlated with schooling. Thus, comparing the task performance of schooled and nonschooled children, completely

disregarding the caste, sex and SES boundaries would only accentuate the problem of selection bias, consequently overestimating the influence of schooling. With due regard to these covarying factors it would be useful to investigate the influence of different types of formal and informal educational experiences on cognitive development. There should always be emphasis on understanding why particular types of learning experiences are associated with improved performance on some cognitive tasks and not on others.

The specific aspects of the teaching-learning conditions adopted in schools can also be experimentally induced to examine if they are capable of producing changes similar to those observed in schools. Through a systematic investigation, one would be able to understand which experiential variables in both school and nonschool settings are related to performance characteristics on various intellectual tasks.

An additional area worthy of exploration is to examine if skills learned in schools generalize to important nonschool settings. Corresponding to each of the test skills, the investigator may look for the instances in the daily-life situations of people in a particular culture, where they utilize a skill closely linked with the one investigated in the experimental situation. One could ask the question, "Do schooled children maintain their superiority in applying the functional test skills in daily-life situations?" Until there is evidence for a

wide-spread application of school-learned cognitive skills, the concept of a change in generalized cognitive structures as function of education would be called into question.

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APPENDIX I

Syllogistic Reasoning Test

Type of of Syllogisms	Items
Familiar	1. Sugar cane grows in hot countries. India is a hot country. Does sugar cane grow there or not?
	2. If it is hot, streams dry up. It was hot last summer. Did the streams dry up or not?
Unfamiliar	3. Wherever it snows, the color of the bears is white. It snows a lot in Soviet Union. What is the color of the bears there?
	4. If the weather gets very cold, rivers turn to ice. In Canada, it was very cold last year. Did the rivers turn to ice there or not?
Artficial	5. Those having wings can fly. If dogs would have wings, would they be able to fly or not?
	6. Those having legs can walk. If trees would have legs, would they be able to walk or not?
Contrary to experience	7. If the horse is well fed, it cannot work well. Ramab Babu's horse is well fed today. Can it work well today or not?
	8. Rice grows well, when it is very hot Next year, it will not be very hot. Will rice grow well next year or not?
Conjunctive	9. A dog and a horse always move together. The horse is moving in the jungle now. What is the dog doing?
	10. Hari and Bana always do things together. Hari is eating now. What is Bana doing?

Type of of Syllogisms	Items
Disjunctive	11. If Rama drinks or Gopal drinks, their father gets angry. Today Rama is drinking, but Gopal is not drinking. Do you think, their father is angry?
	12. If Jadu or Madhu go to see an opera, I go to see an opera. Today, Jadu will go, but Madhu will not go. Do you think, I will go to see an opera?
Implicative	13. So that Rama Babu might be able to carry rice from his village to the nearest town, he needs a cart and some bags. He has the bags, but does not have the cart. Can he carry his rice or not?
	14. So that I might be able to grow cotton, I need a high land, and weather needs to get hot. I have a piece of high land, but the weather is not hot this year. Can I grow cotton this year or not?

APPENDIX II

Table I

A Summary of 'F' Statistics from MANOVA Showing the Effects of Age (A) and Schooling (B) on Piagetian Tasks

Source	df	Four Non-verbal Forms	df	All six Tasks
Age (A)	4	10.23**	6	7.54**
Schooling (B)	4	<1	6	1.77
A X B	4	<1	6	<1
(6-8)Nsch vs (10-12)Nsch	4	5.50**	6	3.83**
(6-8)Sch vs (10-12)Sch	4	4.84**	6	3.95**
(6-8)Nsch vs (6-8)Sch	4	<1	6	<1
(10-12)Nsch vs (10-12)Sch	4	<1	6	1.41
(4-6)Nsch vs (6-8)Nsch	4	3.27**	6	3.47**
(4-6)Nsch vs (6-8)Sch	4	5.38**	6	6.29**
Error	117		115	

* $p < .05$
** $p < .01$

APPENDIX III

Table II

Intercorrelations among Six Cognitive Variables for 4-6 Nonschooled Children (N = 50)

Variables	FC	MFD	DS	ASR	CN	VS
Figure Copying (FC)						
Memory For Designs (MFD)	.866					
Digit Span (DS)	.286	.190				
Auditory Serial Recall) (ASR)	.249	.150	.787			
Color Naming (CN)	-.302	-.295	-.352	-.311		
Visual Search (VS)	-.181	-.155	.035	-.023	.400	

Table III

Intercorrelations among Six Cognitive Variables for 6-8 Nonschooled Children (N = 50)

Variables	FC	MFD	DS	ASR	CN	VS
Figure Copying (FC)						
Memory For Designs (MFD)	.855					
Digit Span (DS)	.366	.437				
Auditory Serial Recall) (ASR)	.408	.404	.704			
Color Naming (CN)	-.447	-.432	-.274	-.324		
Visual Search (VS)	-.036	.033	-.047	.136	.143	

Table IV

Intercorrelations among Eight Cognitive
Variables for 6-8 Schooled Children
(N = 50)

Variables	FC	MFD	DS	ASR	WR	CN	VS	TMN
Figure Copying (FC)								
Memory For Designs (MFD)	.700							
Digit Span (DS)	.186	.035						
Auditory Serial Recall) (ASR)	.181	.156	.771					
Word Reading (WR)	.008	.117	-.093	.037				
Color Naming (CN)	-.174	-.212	-.226	-.317	-.354			
Visual Search (VS)	-.001	.134	-.055	-.174	.019	.142		
Trail Making (Number) (TMN)	-.438	-.387	-.432	-.304	.047	.240	-.270	

Table V

Intercorrelations among Seven Cognitive Variables for 10-12 Nonschooled Children (N = 50 unless otherwise specified)

Variables	FC	MFD	DS	ASR	CN	VS	TMC
Figure Copying (FC)							
Memory For Designs (MFD)	.803						
Digit Span (DS)	.186	.266					
Auditory Serial Recall) (ASR)	.231	.389	.725				
Color Naming (CN)	-.064	-.065	-.235	-.094			
Visual Search (VS)	-.071	-.142	-.019	-.109	.158		
Trail Making (Cards) (TMC) (N = 10)	-.132	-.149	.158	.364	.315	.195	

Table VI

Principal Components Analysis with Varimax Rotation for the 10-12 year old schooled sample (N = 50)

Variables	Factors I	II	III	h2
Figure Copying	-.004	.192	.850	.759
Memory For Designs	.084	-.179	.869	.795
Digit Span	.912	.028	-.110	.845
Auditory Serial Recall	.858	-.157	.003	.760
Word Reading	.609	-.232	.254	.489
Color Naming	-.373	.583	-.091	.487
Visual Serach	-.002	.557	-.459	.521
Trail Making (Cards)	-.098	.755	.017	.580
Trail Making (Number)	-.048	.652	.062	.431
% of Total Variance	23.288	19.924	19.756	